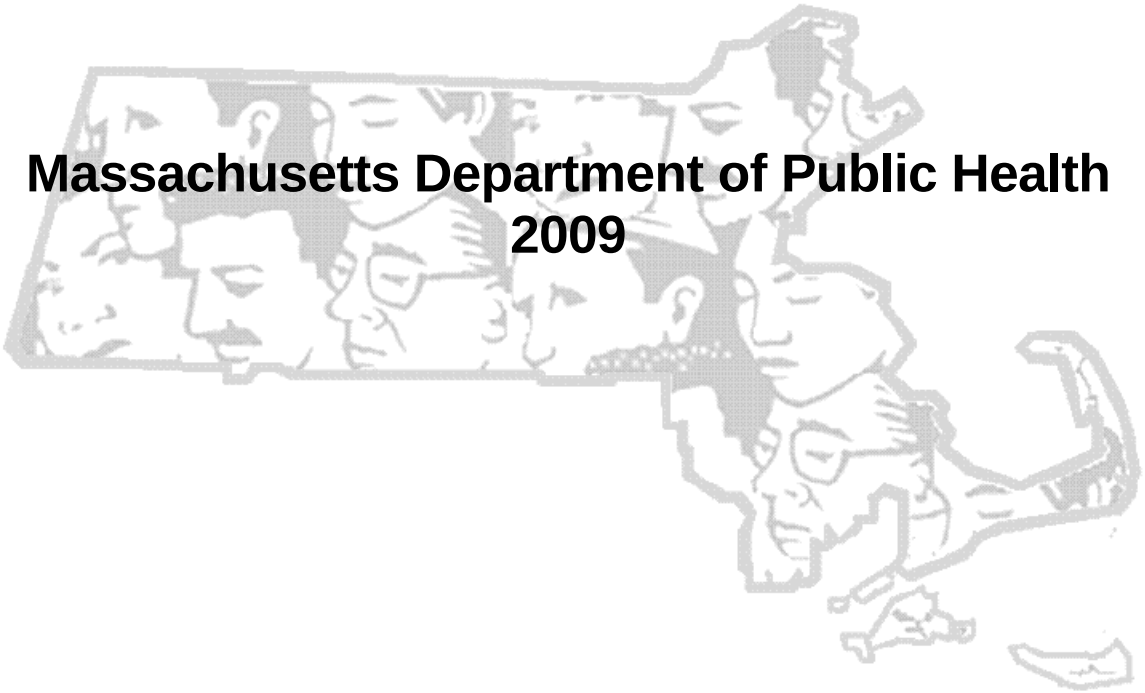
Fatal Occupational Injuries in Massachusetts, 2000–2007



Massachusetts Department of Public Health
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Letitia K. Davis, Director, Occupational Health Surveillance Program

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Massachusetts Department of Public Health
Bureau for Health Information, Statistics, Research and Evaluation
Occupational Health Surveillance Program
250 Washington Street, 6th floor
Boston, MA 02108

617-624-5632

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Preface

This report tells the heartbreaking story of individuals who have been fatally injured at work in Massachusetts during 2000–2007. It is the story of workers who have died doing jobs that enable our communities to function – of construction workers who build our homes and schools and maintain our utility systems, of fishers and farm workers who provide us with the food we eat, of convenience store workers who work through the night, of firefighters, police, and other first responders who routinely put their lives on the line for the greater public good.

The hazards faced by these workers should not simply be accepted as part of the job. There is sound evidence that with effort, occupational risks and hazards can be reduced or eliminated. Alaska, for example, saw a 51% decline in the rate of fatalities among fishermen from 1991 to 2006 that resulted from a significant expansion of safety efforts in the commercial fishing industry.[1] In Ontario, Canada, which has an extensive construction safety program, the rate of fatal occupational injury in the construction industry is approximately half the rate of the construction industry in the United States.[2]

This report would not be complete without acknowledging two groups of Massachusetts workers who died during the period 2000–2007 but are not counted in this report. First are those Massachusetts workers who lost their lives out of state in the *September 11th 2001 Terrorist Attacks.* Second are the Massachusetts servicemen and women as well as civilian workers who have died overseas. We acknowledge the sacrifices of these individuals and honor their memory.

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[1] U.S. Department of Health and Human Services Testimony on Commercial Fishing Vessel Safety before the Committee on Transportation and Infrastructure, Subcommittee on Coast Guard and Maritime Transportation, U.S. House of Representatives, April 2007, Accessed at http://www.hhs.gov/asl/testify/2007/04/t20070425e.html

[2] The Construction Chart Book: The U.S. Construction Industry and its Workforce (4th edition), CPWR – The Center for Construction Research and Training, 2008, Accessed at www.cpwr.com.

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Executive Summary

Work-related fatalities are a significant public health problem in Massachusetts, as they are in the United States. Information about the occupations, industries and circumstances in which these fatalities occur is essential to guide efforts to prevent future fatalities. Since 1991, the Massachusetts Department of Public Health has collected information on all fatal occupational injuries in the Commonwealth as part of the national Census of Fatal Occupational Injuries, conducted in cooperation with the Bureau of Labor Statistics in the U.S. Department of Labor. The Department of Public Health also conducts on-site investigations of fatalities with the aim of identifying workplace factors that increase the risk of fatal injury.

This report provides a comprehensive summary of fatal occupational injuries in Massachusetts during 2000–2007. It includes a comparison of the occupational fatality experience in Massachusetts during this time with that of the nation as a whole as well as with the Massachusetts findings for the previous surveillance period (1991–1999). It also includes more detailed information on one specific topic: falls to lower levels in construction. Findings are intended to guide the many stakeholders – government agencies, employers, unions, safety professionals, advocacy organizations, researchers, job trainers, and equipment design engineers – all of whom have important roles to play in preventing fatal injuries at work.

Key findings:

Overview

- During 2000–2007, a total of 535 workers were fatally injured at work in Massachusetts – an average of more than one worker death each week.

- The annual average rate of fatal occupational injury was 2.1 deaths per 100,000 workers. There was no consistent upward or downward trend in the rate over the eight-year period (Chart 1).

Sex and Age

- The great majority of victims (93%; N=497) were male, and the fatality rate for male workers was almost 12 times higher than the rate for female workers (Chart 2).

- The rate of fatal occupational injury increased with the age of the workers (Chart 3). The fatality rate for workers 65 years of age or older was more than twice the rate for workers less than 35 years of age.

Race, Hispanic Origin, and Nativity

- Workers of Hispanic origin had a higher rate of fatal occupational injury than White non-Hispanic workers (Chart 4).

- Approximately one in five workers fatally injured at work was born outside of the United States, and the fatality rate among foreign-born workers was higher than the rate for U.S.-born workers.

- The Construction industry, a high hazard industry, accounted for the greatest percentage of fatalities among minority workers (28.6%, N=26) and foreign-born workers (34.5%; N=39).

Fatal Event

- Falls to a lower level was the single leading fatal event in Massachusetts, claiming 102 lives during the eight-year period (Table 1).

- Incidents involving a victim being struck by or against an object accounted for 55 deaths and was the second leading event overall (Table 1).

- Transportation-related incidents – including incidents occurring on land, on the water, or in the air – accounted for more fatal occupational injuries (166) than any other event category. Within this category, highway motor vehicle incidents and incidents involving a worker being struck by a vehicle were the most frequently occurring events, resulting in 49 and 44 fatalities, respectively.

Falls to a Lower Level

- Most fatal falls to a lower level occurred in the Construction industry, and this industry had a high rate of fatal falls to a lower level – about 10 times higher than the fatal fall rate for all industry sectors. More than half (51%) of these occurred in small establishments with 10 or fewer employees.

- Roofers and carpenters had the highest number of fatal falls to a lower level.

- A majority of fatal falls to a lower level in the Construction industry occurred from heights of less than 25 feet.

Industry and Occupation

- During the five-year period 2003–2007, the Agriculture, Forestry, Fishing, and Hunting industry sector had the highest fatal occupational injury rate, more than 27 times higher than the rate for all industry sectors (Chart 5). Twenty-nine of the 34 victims in this industry sector worked in commercial fishing (Table 4).

- During the five-year period 2003–2007, the Construction industry sector had the highest number of fatal injuries (103) and one of the highest fatal occupational injury rates. A majority (72%) of the victims worked in a specialty trade such as roofing or siding (Table 4). Close to half of fatal injuries in the Construction sector resulted when workers fell to a lower level.

- During 2003–2007, workers in Farming, Forestry and Fishing occupation group had the highest fatal occupational injury rate, about 34 times higher than the rate for all occupation groups (Chart 6). Most of the workers in this group (29 of 33) were fishers. During 2000–2007, the fatality rate for fishing occupations alone was more than 82 times higher than the rate for all occupations, and Massachusetts was second only to Alaska in the number of commercial fishing deaths during this time period.

- Truck driving claimed more lives than any other single occupation during the full eight-year period (Table 6).

Public Sector, Employment Status, Employer Establishment Size, and Investigations by the Occupational Safety and Health Administration

- During 2000–2007, 40 public sector (government) employees were fatally injured at work. The fatality rate for these government workers was about one-half the rate for all workers.

- Self-employed workers had a fatal occupational injury rate that was three times higher than the rate for wage and salary workers. Self-employed workers are disproportionately employed in high risk industries such as construction.

- Small establishments (with 19 or fewer employees) had a high fatal occupational injury rate, about two times the rate for establishments of all sizes (Chart 7).

- Almost 60% of the occupational fatalities were not inspected by OSHA because a) they did not fall under OSHA's jurisdiction; or b) they resulted from events that are not routinely investigated by the agency; or c) the death occurred more than 30 days after the injury.

Comparison with the previous surveillance period in Massachusetts (1991–1999)

- There was no consistent upward or downward trend in either the numbers or rates of fatal occupational injuries over the 17-year period, 1991–2007 (Chart 8).

- The patterns of fatal occupational injury during the two surveillance periods were generally very similar with several notable exceptions:

    - Whereas Hispanic workers accounted for 5% of the deaths during 1991–1999, they accounted for 10% of the deaths during the more recent surveillance period, reflecting an increase in Hispanics as a percent of the workforce. The fatal occupational injury rate for Hispanics was about 50% higher than the rate for non-Hispanic whites for **both** surveillance periods.

    - Whereas the percent of victims that were older workers (65 years of age or older) remained constant over time (7%), the occupational fatality rate for older workers during 2000–2007 was about half the rate for older workers during the 1991–1999 period.

    - The percent of fatally injured workers who were self-employed increased from 11% in 1991–1999 to 17% in the 2000–2007 period. In both time periods, the Construction industry accounted for the greatest proportion of self-employed victims.

Comparison with the national occupational fatality experience

- Each year from 2000 through 2007, Massachusetts had a lower fatal occupational injury rate than the nation (Chart 9). The difference in rates was explained in part by differences in the industry makeup of the Massachusetts workforce as compared with that of the United States. Low homicide and motor vehicle-related death rates among the population at large in Massachusetts also contributed to the low fatal occupational injury rate for the state.

- Falls to a lower level accounted for a much higher proportion (19.1%) of fatal occupational injuries in Massachusetts than in the nation as a whole (12.0%) (Appendix 2).

Introduction

While the risk of dying on the job in the United States has declined since 1980,[3] there is still much work to be done. Fatal occupational injuries continue to be a significant public health problem in Massachusetts as they are in the country as a whole. From 2000 through 2007, 535 workers died as a result of injuries sustained while at work in the Commonwealth. These deaths are all the more tragic because they were largely preventable. Information about the occupations, industries and circumstances in which these fatalities occurred is essential to guide efforts to prevent future deaths.

This report provides a comprehensive overview of fatal occupational injuries in Massachusetts from 2000 through 2007. Although the Massachusetts Department of Public Health published an annual report on fatal injuries at work for all but one of these years, the numbers from these individual years were too small for meaningful analysis at the detailed level. Eight years of data, however, allow for a more in-depth understanding of the factors associated with fatal occupational injuries in Massachusetts.

This report is based on data collected under two separate but complementary federal programs. The comprehensive surveillance of all fatal occupational injuries sustained in Massachusetts is conducted as part of the national Census of Fatal Occupational Injuries (CFOI), supported by the U.S. Department of Labor, Bureau of Labor Statistics. On-site investigations of selected fatalities are carried out as part of the Fatality Assessment and Control Evaluation (FACE) project funded by the National Institute for Occupational Safety and Health. Both of these projects are carried out in Massachusetts by the Occupational Health Surveillance Program of the Massachusetts Department of Public Health.

Section I of this report provides an overview of fatal occupational injuries in Massachusetts during the eight-year period. Section II includes a comparison of fatal occupational injuries during 2000–2007 with findings for the previous surveillance period (1991–1999). Section III includes a comparison of the occupational fatality experience in Massachusetts during 2000–2007 with that of the nation. Section IV provides more detailed findings on fatal falls in construction. Case examples based on FACE investigations are included throughout the report. This resource document is intended to guide the many stakeholders - government agencies, employers, unions, safety professionals and advocacy organizations, researchers, job trainers, product design engineers, and architects – who have important roles to play in preventing fatal injuries at work.

[3] Worker Health Chartbook 2004, NIOSH Publication# 2004-146. U.S. Depart. of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Accessed www.cdc.gov/niosh/docs/2004-146/pdfs/2004-146.pdf on 9/12/08.

Methods

Definition of Fatal Occupational Injuries

A fatal occupational injury is defined as a death resulting from traumatic injury or other external cause that occurred while the person was at work. This definition includes fatalities due to acute exposure to toxic chemicals or physical agents as well as lack of such essentials as heat or oxygen. Examples include those events traditionally linked with factors in the work environment such as falls, electrocutions, and crushings, as well as workplace homicides and suicides and motor vehicle fatalities that occur while traveling on the job. The CFOI and FACE projects do not include injuries that occur while commuting to or from work. Deaths caused by occupational illness and most fatal heart attacks are also excluded.

Included in this report are all fatal occupational injuries that occurred while the victims were working or traveling for work in Massachusetts regardless of their state of residence, state of death, or state of origin of travel. The count does not include victims who died in Massachusetts but sustained injuries while working in other states. Fatal occupational injuries that occurred in the ocean are included if a) the fatal injury occurred within the 200-miles offshore economic zone of the United States and the incident location was more proximal to Massachusetts than any other state; and/or b) a death certificate was issued by the state of Massachusetts.

Definition of Work-relatedness

An injury is considered work-related if the injury a) occurred on the employer's premises while the person was there to work; or b) occurred off the employer's premises while the person was there to work or there as a requirement of his or her job. It includes injuries that occurred while the worker was traveling as part of his or her employment. Work is defined as a duty or activity that produces a product or service, is done in exchange for money, goods, profit or benefit and is legal in the U.S.

The victims counted in this report include the self-employed as well as those employed by others. Deaths of volunteers who perform the same duties as paid workers are also counted.

Sources of Data

The Occupational Health Surveillance Program (OHSP) in the Massachusetts Department of Public Health has collected occupational fatality data as part of the Census of Fatal Occupational Injuries (CFOI) program since 1991. Data on fatal occupational injuries throughout the United States are from the national CFOI reports published by the BLS.[4] Both the Massachusetts and the national CFOI data for the year 2007 are preliminary.

In implementing CFOI, OHSP uses multiple data sources to identify and document fatal occupational injuries. They include death certificates, workers' compensation records, newspaper articles, medical examiner reports, FARS (Fatality Accident Reporting System) reports, Occupational Safety and Health Administration (OSHA) records, Coast Guard reports, as well as police and other first responder reports. Other available federal and state administrative sources are also used. In some cases, employers are contacted through follow-up questionnaires to obtain additional information. CFOI requires that the work relationship be substantiated by two or more independent sources to assure accuracy of the data.

[4] Census of Fatal Occupational Injuries, Bureau of Labor Statistics, U.S. Department of Labor, http://www.bls.gov/iif/osh_nwrl.htm#cfoi

Coding

The fatality data collected are coded using standard classification schemes as required by the national CFOI program:

Industry: This variable reflects the type of establishment or business in which the person was employed at the time of the fatal injury. Prior to 2003, industry was coded using the *Standard Industrial Classification (SIC)* system.[5] From 2003 forward, industry has been coded according to the *North American Industry Classification System (NAICS).*[6]

Occupation: Occupation describes the work that the person was doing at the time of his/her injury. Prior to 2003, occupation was coded according to the *Occupational Injuries and Illnesses Occupation Coding Manual.* [7] From 2003 forward, the *Standard Occupational Classification* (SOC) system [8] has been used to classify occupation.

Because of the substantial differences between the current and previous industry classification systems, 2003 marks a break in series, precluding most comparisons between the industry data prior to 2003 with industry data from later years (2003–on). Similarly, the previous (pre-2003) and current (2003-on) occupation classification systems are not comparable. Thus, the industry and occupation findings in this report are based on data for 2003–2007 only, unless otherwise noted.

Event/Exposure, Body Part Affected and Source of Injury were coded according to the *Occupational Injury and Illness Classification Manual.* [9] The event or exposure describes the manner in which the fatal injury occurred (e.g. fall, roadway collision, struck by object). The injury source identifies the object, substance, or bodily motion that inflicted the fatal injury (e.g. vehicle, bullet, carbon monoxide).

Other Data Elements: Other variables such as age, sex, race, ethnicity, nativity, employee status and establishment size are coded according to the *Census of Fatal Occupational Injuries State Operating Manual*.[10] The information about, race, ethnicity and nativity is based on information recorded on death certificates.

Fatal Occupational Injury Rates

Unless otherwise noted in this document, the average annual fatal occupational injury rates for the period 2000–2007 are reported. They were computed as: (a) the sum of the fatal occupational injuries over the eight-year period, *divided by* (b) the sum of workers employed in Massachusetts each year over the eight-year period, *multiplied by* (c) 100,000. These rates are expressed as fatalities per 100,000 workers.

Annual average estimates of the numbers of workers employed in Massachusetts were obtained from the Current Population Survey (CPS) using a public use application *DataFerrett,*[11] except where noted. The CPS is a monthly survey of a sample of households conducted by the Census Bureau for

[5] Executive Office of the President, United States, 1987, Standard Industrial Classification Manual, Washington, D.C.: Office of Management and Budget.

[6] Executive Office of the President, United States, 2002, North American Industry Classification System Manual, Washington D.C.: Office of Management and Budget.

[7] Occupational Coding Manual: Occupational Injuries and Illnesses, U.S. Department of Labor, Bureau of Labor Statistics. (Adopted from the Bureau of Census 1990 Alphabetical Index of Industries and Occupations), 1993 (revised 2000).

[8] Executive Office of the President, United States, 2000, Standard Occupational Classification Manual, Washington, D.C.: Office of Management and Budget.

[9] Occupational Injury and Illness Classification Manual, U.S. Department of Labor, Bureau of Labor Statistics. 1992.

[10] Program Guide for the Census of Fatal Occupational Injuries Program, U.S. Department of Labor, Bureau of Labor Statistics.

[11] U.S. Census Bureau, DataFerrett, Current Population Survey, August 2008.

the Bureau of Labor Statistics that produces annual estimates of the civilian, non-institutionalized labor force (employed and unemployed persons). Fatalities involving youth workers less than 16 years old and resident military were excluded from all rate calculations because CPS employment data are limited to civilian workers 16 years and older. The CPS employment data are based upon a sample rather than a complete count; therefore, the CPS estimates and resulting fatality rates have sampling errors. Also, the CPS data include estimates of workers who reside in Massachusetts, whereas the CFOI data include victims (residents and non-residents of Massachusetts) who were fatally injured in Massachusetts. This may result in a slight over-estimation of the fatality rate if deceased persons working in Massachusetts were out-of-state residents and a slight under-estimation if deceased workers were Massachusetts residents but were fatally injured in other states. Rates were not calculated for categories with counts less than five, and rates based on small numbers (less than 20 deaths) should be interpreted with caution.

The fatal occupational injury rate indicates the probability or risk of a worker being fatally injured on the job. In a large industry, many workers may be fatally injured but the rate may be low. Conversely, in a small but high-risk industry, the number of workers fatally injured may be small but the rate or risk may be high. Both rates and numbers should be taken into account when targeting prevention efforts.

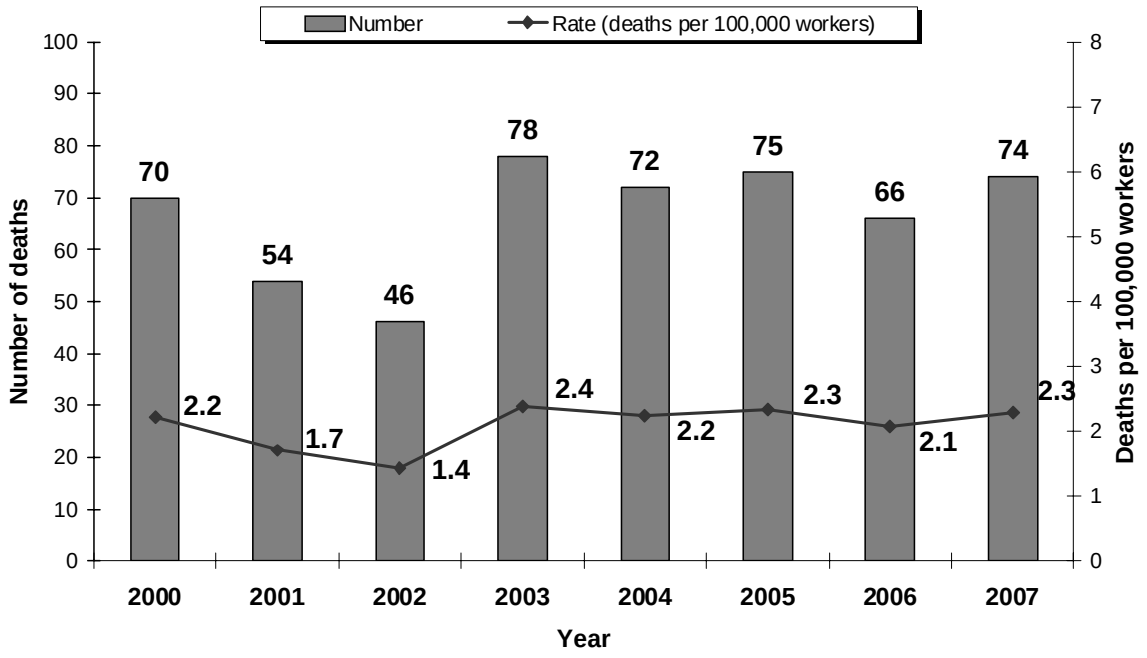
Comparison of Trends and Rates: In this report, trends (over time and across groups) and the comparison of rates were assessed using standard, statistical methods. These methods indicate whether the trends or the differences between two rates were unlikely to have occurred by chance (i.e. were 'statistically significant'). Throughout this report, the comparative terms 'higher', 'lower', 'increased', 'decreased', etc. were used **only** when there was a 5% chance or less that the finding was due to sampling error alone (i.e. the finding was 'statistically significant' at the 95% probability level). Further methodological details are discussed in Appendix 3.

I. Fatal Occupational Injuries in Massachusetts

1.1 Overview

- During 2000–2007, a total of 535 workers were fatally injured at work in Massachusetts, an average of 67 fatalities a year or more than one worker death each week (1.3 fatalities per week). Eight-three percent (444) of these victims were residents of Massachusetts.[12]
- The average annual rate of fatal occupational injury for the eight-year period was 2.1 deaths per 100,000 civilian workers.
- The 535 fatalities resulted in a total of 17,056 potential years of life lost, an average of 32 potential years of life lost per death. Potential years of life lost is the difference between the victim's age and 75 years.
- The number and rate of fatal occupational injuries per year in Massachusetts fluctuated over time (Chart 1); there was no consistent upward or downward trend over the eight year period.

Chart 1. Number and Rate of Fatal Occupational Injuries *by Year*, Massachusetts, 2000-2007 (N=535)



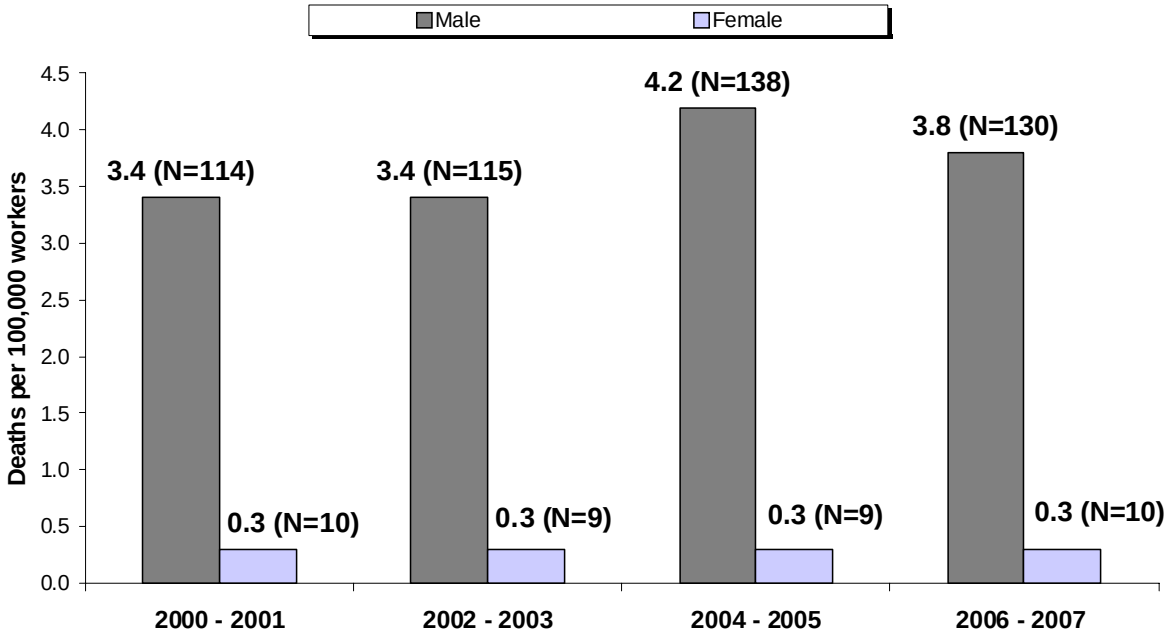
1.2 Sex

- The great majority of workers (93%; N= 497) who were fatally injured at work were men. Women accounted for the remaining 7% (38) of the deaths.

[12] This number (444) does not include the Massachusetts residents fatally injured out-of-state. They are counted among other states' CFOI cases.

- The fatal occupational injury rates for men were consistently much higher than the rates for women over the eight year time period. (Chart 2). The average annual fatality rate for male workers (3.7 deaths per 100,000 workers) was almost 12 times higher than the rate for female workers (0.3 deaths per 100,000 workers) – a finding consistent with the national experience. For the U.S. during this time period, the average annual rate of fatal occupational injury for men was 6.9 deaths per 100,000 workers compared with 0.7 deaths per 100,000 workers for women.[4]

Chart 2. Rate of Fatal Occupational Injuries *by Sex*, Massachusetts, 2000-2007 (N=535)



- The difference in fatality rates for men and women may be explained in large part by the fact that men are more likely to be employed in high risk jobs. For example, during 2003–2007 in Massachusetts, proportionately more men (23%) than women (2%) were employed in the following four occupation groups with high fatality rates: Farming, Forestry & Fishing; Construction & Extraction; Installation, Maintenance & Repair; and Transportation & Material Moving.[13] Conversely, 76% of female workers compared to 58% of male workers were employed in four occupation groups with low fatality rates: Management, Business & Financial; Professional & Related; Sales; and Office & Administrative Support.

- The events resulting in death differed for male and female workers. The two leading fatal events among women were homicide (37%; N=14) and roadway collisions (13%; N=5) which together accounted for one-half of all female deaths. In contrast, a fall to a lower level was the leading event among male workers (20%; N=99) followed by struck by or against objects (11%; N=54), and roadway collisions (9%; N=44). Homicide accounted for 7% (35) of the deaths among men.

- Notably, while homicide accounted for a much higher proportion of fatal occupational injuries among women, the rate of workplace homicide for women was 0.1 per 100,000 workers compared to a rate of 0.3 per 100,000 workers for men.

[13] U.S. Census Bureau, DataFerrett, Current Population Survey data 2000–2007, August 2008.

1.3 Age

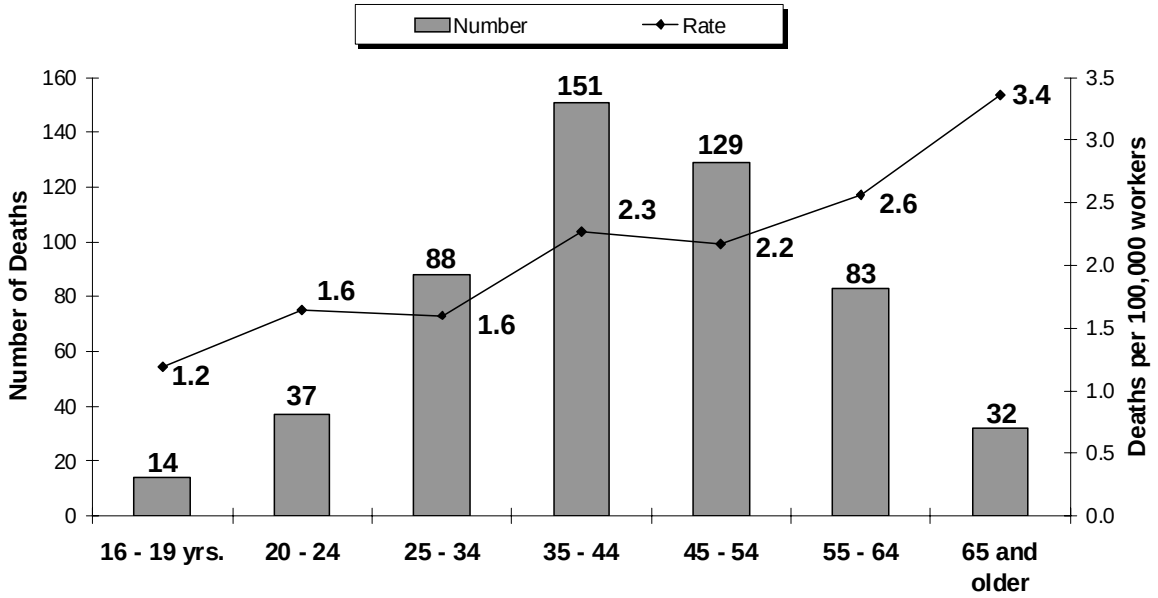
- The victims ranged in age from 15 to 89 years with an average age at death of 43 years. Three-quarters of the workers (401) were 53 years of age or younger.

- The fatal occupational injury rate increased with increasing age (Chart 3), similar to findings at the national level.[4]

- The fatality rate for workers 65 years of age or older (3.4 deaths per 100,000 workers) was more than twice the rate for workers less than 35 years of age (1.6 deaths per 100,000 workers) (Chart 3). The 32 older victims worked in a wide range of jobs: seven were employed as truck drivers, five worked in construction, five were managers/supervisors, four were installers, repairers, or mechanics, and three were farm/agricultural workers. The remaining eight victims 65 years or older worked in a variety of occupations including protective and social services, building cleaning, grounds maintenance, education, and other technical professions.

- Nine workers (1.7%) less than 18 years of age lost their lives while working during 2000 through 2007. These included: three teen workers killed when the vehicles they were operating (forklifts, golf cart) overturned or crashed; two teen workers struck by falling objects (granite slabs, a jacked truck); one teen electrocuted while dismantling a scaffold, one teen working on a scalloping vessel that sank, and one teen working for an electrician who died of complications after tearing a muscle while doing heavy lifting.[14] Another teen died when he fell 23 feet from the edge of a church roof while transporting building materials.[14]

Chart 3. Number and Rate of Fatal Occupational Injuries *by Age Group* , Massachusetts, 2000-2007 (N=534)



[14] Data provided by the Fatality Assessment and Control Evaluation (FACE) project, Occupational Health Surveillance Program, Massachusetts Department of Public Health, 2000 – 2007.

16-Year-Old Cleaning Helper Crushed by Forklift

A 16-year-old part-time cleaning helper was fatally injured when the forklift he was operating at a seafood processing/retail facility overturned, crushing his chest. The victim was using the forklift to move a wooden pallet that had been loaded with trash and raised approximately 4½ feet. He had been employed with the company for approximately 18 days, and his training was on-the-job and conducted by other teen employees.

To prevent similar incidents, MA FACE recommended that employers should: 1) comply with federal and state child labor laws which prohibit youth less than 18 years old from operating forklifts; 2) train all forklift operators in safe operating procedures; 3) provide adequate supervision for young workers, new employees and any inexperienced worker; and 4) develop, implement and enforce a health and safety program (MA FACE report 00MA058).

- Fatality rates calculated using number of workers employed underestimate t he risks faced by both older (greater than 64 years) and younger (less than 18 years) workers. Workers in both these age groups are more likely to be employed part-time; therefore their rates would be higher in relation to workers in other age groups when actual total work hours were taken into account.[15]

- The events resulting in death varied by age. Thirty-eight percent (12) of the victims 65 years or older died as a result of falling compared with 21% (104) of victims less than 65 years of age. Half of the 12 fatal falls among the older worker group were on the same level compared with only 8% of the 104 falls among the younger age group.

1.4 Race and Hispanic Origin

- Eighty-two percent (429) of the fatally injured workers were White non-Hispanic, 4% (22) were Black non-Hispanic and 3% (15) were Asian non-Hispanic. Ten percent (54) were of Hispanic origin; 33 of these Hispanic victims were born outside of the U.S. (Chart 4). Twenty-one Hispanic victims were from Mexico or Central America including 13 from Guatemala; eight were from South American (including Ecuador, Brazil, Columbia, and Peru); and four were from the Caribbean (Cuba or the Dominican Republic).

- Hispanic workers had a higher rate of fatal occupational injury (3.1 fatalities per 100,000 workers) than White non-Hispanic workers (2.0 fatalities per 100,000 workers) (Chart 4). This finding is consistent with earlier findings for Massachusetts[16] and with findings nationwide.[17]

- A high fatal occupational injury rate among Hispanic workers is in part explained by the disproportionate employment of Hispanic workers in more dangerous jobs.[18] Yet even within a high risk industry – construction – the fatality rate for Hispanic construction workers in Massachusetts during the eight year period (13.0 deaths per 100,000) was higher than that for their White non-Hispanic counterparts (7.8 deaths per 100,000 workers.)[19] Hispanic workers may be more likely to be employed in construction jobs where hazards are not adequately controlled. Many other factors may also contribute to their increased risk. These include inadequate

[15] Ruser, J. Denominator Choice in the Calculation of Workplace Fatality Rates, Fatal Workplace Injuries in 1996: A Collection of Data and Analysis, U.S. Department of Labor, Bureau of Labor Statistics, June 1998.

[16] Fatal Occupational Injuries in Massachusetts 1991–1999, Occupational Health Surveillance Program, Massachusetts Department of Public Health, Sept. 2002.

[17] Centers for Disease Control and Prevention (CDC). Work-Related Injury Deaths Among Hispanics – United States, 1992–2006. Morbidity and Mortality Weekly Report (MMWR) 2008; 57:597-600.

[18] Richardson S, Ruser J, Suarez P, Hispanic workers in the United States: An analysis of employment distributions, fatal occupational injuries, and non-fatal occupational injuries. In: Safety is seguridad: a workshop summary. Washington, DC: The National Academies Press. 2003.

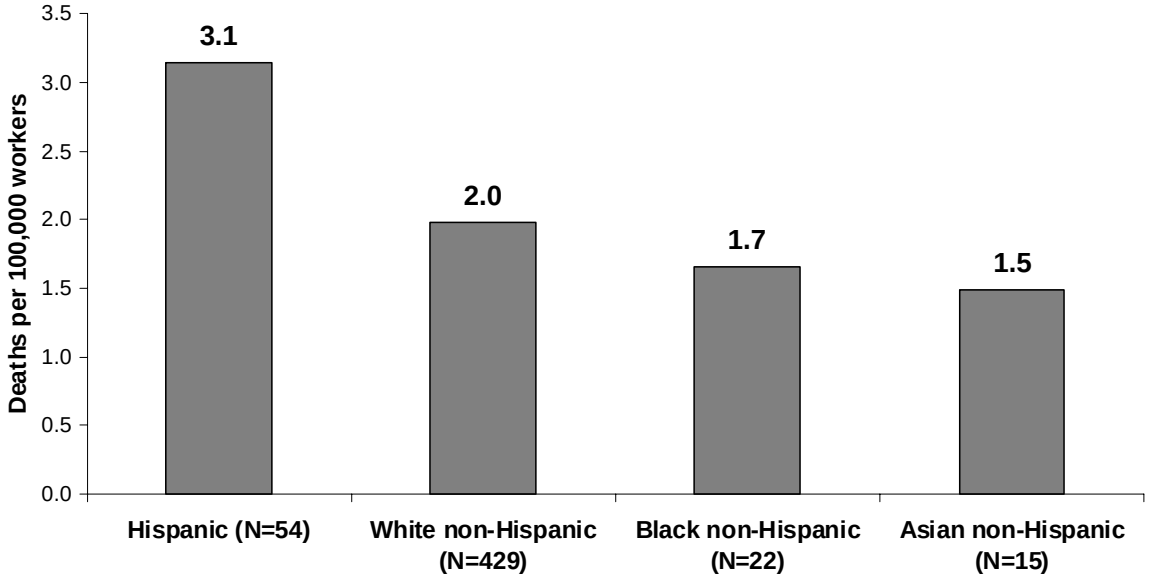
[19] This difference in rates is based on small numbers and is not statistically significant; however, it is consistent with findings reported elsewhere. (Dong X, Platner JW, Occupational fatalities of Hispanic construction workers from 1992–2000. Am J Ind. Med. 45(1):45-54. 2004.)

experience, training or supervision; language, literacy and cultural barriers in the workplace, and fear of discrimination as well as economic pressures that deter workers from speaking up about workplace hazards.[18]

- The industry sectors in which high numbers of fatal injuries occurred varied little by race and ethnicity (Appendix 1). During 2000–2007 in Massachusetts, (31%; N=17) of Hispanic worker deaths occurred in the Construction industry (Appendix 1). Nationally, this percentage was 34%.[17] The Construction industry also accounted for the most deaths among the White non-Hispanic (27.7%; N=119) and Asian non-Hispanic (40%; N=6) victims. Among Black non-Hispanic victims, the Services industry accounted for the greatest number of deaths (8) (Appendix 1).

- The events resulting in death varied by race/ethnicity of victims. Falls were the leading event among Hispanic and White non-Hispanic workers. Fire/explosion was the leading event among Asian workers, and homicide was the leading event among Black workers (Appendix 1).

Chart 4. Rate of Fatal Occupational Injuries *by Race and Hispanic Ethnicity*, Massachusetts, 2000-2007 (N= 522)



NOTE: The Hispanic employed workforce is reportedly underestimated by 10%.[20] The rate is adjusted for this underestimation. The unadjusted rate was 3.5 fatalities per 100,000 workers. Race and/or Hispanic origin data were not available or unknown for 13 workers. Rates not calculated for race/ethnicity groups with < 5 fatalities.

[20] McKay, R. Cultural factors affecting within household coverage and proxy reporting in Hispanic households. A pilot study. Proceedings of the Section on Survey Research Methods. American Statistical Association. 614-618. 1992.

Hispanic Temporary Worker Fatally Struck by Equipment

A 30-year-old Hispanic male employed as a temporary worker was fatally injured at a concrete casting facility. While assisting with the removal of a 1,000-gallon concrete septic tank from its form, the victim was struck in the head and back by the boom of the turning device used for this task. The boom slipped off of the forklift tines that had been supporting the device. The victim's first language was Spanish and the first language of the person he typically worked with, a permanent company employee, was English. The company did not have a written safety and health program, and the only training provided was on-the-job.

To prevent similar incidents, MA FACE recommended that employers should: 1) develop a locking mechanism to ensure that concrete casting turning devices used with forklifts are securely attached to the tines; 2) provide barrier guards to ensure that all employees are safe from possible hazards while completing tasks; 3) establish procedures for rotating concrete castings; 4) consider using an overhead crane system for rotating concrete castings; 5) ensure that workers employed through temporary agencies are provided site- and task-specific safety and health training; and 6) ensure that workers who are part of a multi-lingual workforce comprehend safety training for their assigned tasks (MA FACE report 02MA016).

1.5 Events/Exposures

- **Transportation-related incidents** accounted for more fatal occupational injuries (31%; N= 166) that any other broad event category during the eight-year period. Forty-nine victims were vehicle occupants who were fatally injured in roadway collisions, followed by 44 victims who were struck by vehicles in parking lots, on roadways, railroad tracks, or off-road areas. Thirty-five workers died in water vehicle incidents, 20 were killed operating vehicles off-road and 17 died in aircraft crashes (Table 1). Eleven single or twin-engine planes crashed and resulted in the deaths of 14 pilots/co-pilots and 3 workers who were traveling for business.

- **Falls** accounted for more than one-fifth (22%; N=117) of all fatal occupational injuries (Table 1). Falls to a lower level accounted for the majority of these fatal falls, claiming 102 workers' lives and resulting in more fatalities than any other single event. Falls from a scaffold or roof accounted for 41% of all falls to a lower level (Table 2). Sixty-nine percent (70) of the falls to a lower level occurred in the construction industry. (See Special Topic: Falls to a Lower Level in Construction).

- **Contact with objects or equipment** accounted for 17% (91) of the fatal occupational injuries (Table 1). Thirty-four victims died after being struck by falling objects such as building materials, jacked vehicles, heavy machinery, or trees. Another 15 workers were killed when they were struck by rolling or shifting vehicles that were not in normal operation. Becoming caught in running machinery or equipment claimed the lives of an additional 17 workers (Table 2).

Machine Operator Caught in a Shirt Pressing Machine

A 44-year-old female machine operator was fatally injured when she became caught in a shirt pressing machine. While the machine was in operation, the victim reached down into an opening in the loading table and became stuck. The machine cycled, crushing the victim's arm, neck and chest. The victim had been employed with the company for 19 years. The equipment manufacturer provided only one training session – at the time the machine was delivered eight years prior to the incident.

To prevent similar incidents, MA FACE recommended that employers should: 1) ensure that accessible and exposed mechanical hazards are guarded; 2) ensure that pressing machines are equipped with emergency stop buttons; 3) periodically perform hazard analyses to ensure equipment is safe to operate; 4) train equipment operators and employees on all aspects of the equipment, including functions that are not routine.

In addition, shirt pressing machine manufacturers should: 1) design machines with unexposed moving parts and with emergency stops that are linked to the pneumatic system; and 2) explore the possibility of reducing the force used to transfer the shirt to and from the loading and pressing areas (MA FACE report 02MA002).

- **Assaults and violent acts** was the fourth leading event category, accounting for 17% (90) of the fatalities (Table 1). Homicide was the third leading event overall, claiming a total of 49 workers' lives, while suicide at work accounted for 39 fatalities. In more than one-half (53%) of the workplace homicides, firearms were used as the means of assault, similar to the finding for all homicides (workplace and community) statewide (56%).[21] However, there are characteristics of workplace homicides that distinguish them from homicides in general. For instance, robbery was the leading motive among 50% (19) of the 38 workplace homicides for which circumstance information was available; whereas robbery was responsible for only about 9% of all homicides in Massachusetts during 2003 and 2006.[22] Twelve current or former co-workers were murdered. Seven of these co-workers were shot by another employee apparently disgruntled over a work-related, financial situation.

- Forty-three workers (8%) died from **exposure to harmful substances or environments** at the workplace. Twenty of these workers were electrocuted, six died from carbon monoxide poisoning, and six drowned (Table 2). More than half (11) of the fatal electrocutions resulted from contact with overhead power lines prompting the Massachusetts FACE project to issue a Safety Alert describing the hazards of working near energized power lines and recommending safety procedures.
  Refer to www.mass.gov/Eeohhs2/docs/dph/occupational_health/overhead_line.pdf

- Twenty-seven workers (5%) were fatally injured in a **fire or explosion** event during the eight-year period. Fire incidents claimed the lives of 16 workers while nine workers died from pressure vessel explosions (Table 2). Three victims of fire incidents were fire fighters who were fatally injured in the line of duty. A fire in an office building claimed the lives of five workers. In two separate fires within a 10 month period, three wood floor sanders were fatally burned and another two sustained serious burn injuries when the flammable lacquer floor sealer they were using ignited. The Massachusetts FACE project, in conjunction with the Office of the State Fire Marshall, released a Fire Safety Alert (available in English and Vietnamese) in response to these incidents.
  Refer to www.mass.gov/Eeohhs2/docs/dph/occupational_health/wood_floor_sanders.pdf and see box on next page.

[21] Massachusetts Death file 2000–2006. Massachusetts Registry of Vital Records and Statistics, Retrieved by the Injury Surveillance Program, Bureau of Health Information, Statistics, Research, and Evaluation, Massachusetts Department of Public Health.

[22] Massachusetts Violent Death Reporting System 2003–2006, Injury Surveillance Program, Massachusetts Department of Public Health.

Wood Floor Sanders Killed When Floor Finishing Product Catches Fire – Massachusetts

Wood floor finishing can expose workers, building occupants, and homeowners to fire hazards. In Massachusetts, three wood floor sanders died within a 10 month period (September 2004–July 2005) in two separate fires when the flammable, quick-drying lacquer floor sealer they were using caught fire. All three of the fatally injured workers were Vietnamese immigrants.

HOW TO PREVENT FIRE DURING FLOOR FINISHING

Massachusetts FACE recommends that employers should do the following:

1) Use less flammable wood floor finishing products (products with flash points greater than 100°F/38°C) for indoor applications.
2) Ensure that all open flames and other ignition sources, including gas pilot lights, are extinguished before beginning work
3) Ensure that work areas are adequately ventilated during wood floor finishing.
4) Provide safety training to employees, as required by law, about the hazards of the chemicals they work with and safe work practices. Training should be provided in the languages spoken by employees.
5) Conduct a job hazard analysis before each job. Also require employees to complete a safety checklist before beginning each job.

Additional recommendations for the wood floor finishing industry, homeowners, policymakers, and other stakeholders can be found in the FACE Report #04MA032 at http://www.cdc.gov/niosh/face/stateface.html

MASSACHUSETTS IS TAKING STEPS TO ELIMINATE FLOOR FINISHING HAZARDS

The Massachusetts Floor Finishers Task Force comprising community development and other advocacy groups, floor industry representatives, and product distributors/manufacturers are working to reduce the use of highly flammable floor finishing products by: a) providing hands-on training to floor finishers on the use of safer and higher quality product alternatives; b) educating homeowners and other consumers on floor finishing hazards in order to create demand for environmentally preferable products; and c)promoting legislation in Massachusetts to prohibit the use and sale of highly flammable floor finishing products.

Table 1. Number and Rate of Fatal Occupational Injuries *by Event/Exposure*, Massachusetts, 2000–2007

Event/Exposure	Number of Fatalities	Percent	Rate (Fatalities per 100,000 workers)
Transportation Incidents	**166**	**31.0**	**0.6**
Highway motor vehicle incident	*49*	*9.2*	*0.2*
Worker struck by vehicle	*44*	*8.2*	*0.2*
Water vehicle incident	*35*	*6.5*	*0.1*
Non-highway motor vehicle incident	*20*	*3.7*	*0.1*
Aircraft incident	*17*	*3.2*	*0.1*
Falls	**117**	**21.9**	**0.5**
Fall to a lower level	*102*	*19.1*	*0.4*
Fall on same level	*14*	*2.6*	*0.1*
Contact with object or equipment	**91**	**17.0**	**0.4**
Struck by or against object	*55*	*10.3*	*0.2*
Caught/Compressed by object, equipment, collapsing material	*36*	*6.7*	*0.1*
Assault and Violent Act	**90**	**16.8**	**0.4**
Homicide	*49*	*9.2*	0.2
Suicide/Self-inflicted Injury	*39*	*7.3*	0.2
Exposure to Harmful Substances or Environments	**43**	**8.0**	**0.2**
Contact with electric current	*20*	*3.7*	*0.1*
Other exposure to harmful substances or environments	*16*	*3.0*	*0.1*
Oxygen deficiency (includes drowning)	*7*	*1.3*	*0.03*
Fire or Explosion	**27**	**5.1**	**0.1**
Total	**535**	**100%**	**2.1**

NOTE: Bolded numbers and percents of fatalities do not total because one fatality resulting from a bodily motion or from excessive physical effort is not included in Table 1. Bolded rates do not total due to rounding. Event/Exposure sub-categories with < 3 fatalities were not included in Table 1.

Carpenter Dies from Exposure to Carbon Monoxide

A 43-year-old self-employed finish carpenter died from carbon monoxide (CO) poisoning, while he was working inside a metal storage container where a gasoline powered generator was operating. The victim was using the generator to provide energy for a light. The victim had 15 years of experience and had worked for the same home builder / general contractor on a large residential and commercial development for approximately seven years.

To prevent similar incidents, MA FACE recommended that employers should: 1) always leave fuel-burning generators outside of buildings and storage containers when operating and 2); ensure carbon monoxide detectors are used when fuel-burning generators are running and employees are located at indoor and/or partially enclosed work sites. In addition, home builders / general contractors of large construction projects should provide electricity at long term tool and equipment storage locations.

Manufacturers of fuel-burning generators should: 1) provide warnings about the hazards of carbon monoxide associated with fuel-burning generators on labels permanently affixed to the generators and 2) promote research to develop fuel-burning generators that reduce carbon monoxide emissions (MA FACE report 06MA059).

Table 2. Leading Events/Exposures resulting in Fatal Occupational Injuries, Massachusetts, 2000–2007

Event/Exposure Category	Events/Exposures with Three or More Occupational Fatalities *(Number of fatalities in parentheses)*
Transportation Incident (166)	Highway motor-vehicle related incident (49) *Collision between vehicles or mobile equipment (31),* *Collision between mobile vehicles and stationary objects or vehicles (13)* *Non-collision incident (5)]* Worker struck by motor vehicle or mobile equipment (44) Water vehicle incident (35) *Sinking , capsizing water vehicle (18)* *Fall from ship or boat (7)* *Collision (3)* Non-highway motor vehicle related incident (20) *Non-collision incident (18)* Aircraft crash (17)
Falls (117)	Fall from scaffold, staging (21) Fall from roof (21) Fall on same level *[to floor, walkway, or other surface]* (14) Fall to a lower level, unclassified (13) Fall through opening in the floor or roof (12) Fall from non-moving vehicle (12) Fall from ladder (12) Fall from girders or other structural steel (5) Fall down stairs or steps (4)
Contact with Object or Equipment (91)	Struck by falling objects (34) *Structural/building materials (14)* *Non-operational/jacked vehicles or heavy machinery (9)* *Trees (7)* Struck by dislodged/discharged flying object (4) Struck by rolling vehicles that were not in normal operation (15) Caught in running machinery or equipment (17) Compressed or pinched by or between vehicles/heavy machinery (9) Caught in or crushed in collapsing structures, vehicles, or other materials *[including cave-ins]* (8)
Assault and Violent Act (90)	Homicide (49) *By shooting (26)* *By stabbing (17)* *By strangulation or other means (6)* Suicide/self-inflicted injury (39)
Exposure to Harmful Substances And Environments (43)	Electrocution and other injuries resulting from contact with electric current (20) Carbon monoxide poisoning (6) Other inhalation of substance (4) Drowning, submersion (6) Injection, sting, venomous bite (3)
Fire or Explosion (27)	Unintended fire in residence, building, or other structure (16) Explosion of pressure vessel or piping (9)

NOTE: Event/Exposure sub-categories with < 3 fatalities were not included in Table 2.

1.6 Industry [23]

- During the five-year period 2003–2007, the **Agriculture, Forestry, Fishing, & Hunting** industry sector had the highest fatal occupational injury rate – more than 27 times higher than the overall state rate – but only the fifth highest fatality count with 34 deaths (9%) (Chart 5). Twenty-nine (85%) of these fatal injuries occurred in the fishing industry (Table 4). (See Section 1.7 for a further discussion of the fishing-related fatalities.)

- The **Construction** industry sector had the highest fatality count with 103 deaths (19%) and one of the highest fatal occupational injury rates (9.7 deaths per 100,000 workers) during 2003 – 2007 – more than four times higher than the overall state rate (Chart 5). Nearly three in four (72%; N= 74) of the construction workers fatally injured on the job were employed in the specialty trade contractor sector which includes, among others, roofing/siding, electrical, steel erection, site preparation and masonry (Table 4). Close to half (48%; N=49) of fatal injuries in the construction industry resulted from falls to a lower level. (See Special Topic: Falls to a Lower Level in Construction)

Brazilian Roofer Electrocuted by Contact with Overhead Power Lines

A 40-year-old male Brazilian roofer was electrocuted and a co-worker was seriously shocked when the partially extended 32-foot aluminum extension ladder they were unloading from their truck came in contact with a 7,620 volt energized overhead power line. The victim had been employed with his friend's company for a few weeks at the time of the incident and had no previous experience as a roofer. The company did not have a safety and health program, but did provide employees some safety training which did not address overhead power lines.

To prevent similar incidents, MA FACE recommended that employers should: 1) eliminate the use of conductive ladders in proximity to energized overhead power lines; 2) conduct jobsite surveys prior to the start of construction projects to identify potential hazards, such as energized overhead power lines, and to implement appropriate control measures for these hazards; 3) ensure that loading and unloading of construction equipment and materials from vehicles are not performed beneath overhead power lines; and 4) develop, implement, and enforce a safety program and provide training in the language(s) and literacy level(s) of workers (MA FACE report 04MA038).

- During 2003–2007, the **Transportation, Warehousing and Utilities** industry sector had the second highest fatality count with 43 deaths (12%) and one of the highest fatal occupational injury rates (9.3 deaths per 100,000 workers) – four times higher than the overall rate for the state (Chart 5). Almost one-third of these fatalities (14) occurred in the freight trucking industry (Table 4). Struck by mobile vehicles/equipment and aircraft incidents were the leading fatal events in this industry, each accounting for nine deaths (Table 4).

- The **Other Services** industry sector is comprised of equipment and automotive repair/ maintenance establishments, personal care services, civic and professional organizations, and private households. Ten of the 16 workers fatally injured in this industry sector were employed in automotive or auto body repair (Table 4). Five of these automotive/autobody workers were pinned or crushed by a vehicle moving in reverse or falling off a lift.

- Workplace homicide was the leading event resulting in fatal occupational injury among workers in the **Leisure and Hospitality** industry sector, accounting for 11 of the 23 fatalities (Table 4). Nine of the 11 homicides occurred in restaurants and bars.

[23] With the exception of Table 4, findings by industry in this section cover ONLY 2003 – 2007 due to changes in the industry classification systems between 2002 and 2003 (discussed earlier) that preclude many precise comparisons between fatal occupational injury data (pre - 2003) and the more current data (2003 – 2007).

- The **Trade** industry sector had 40 fatalities during the five-year period from 2003 through 2007. One–quarter (10) of the occupational fatalities in this sector were homicides, all of which occurred in retail businesses. Among the six victims fatally struck by vehicles or equipment in the Trade industry, four were crushed or pinned by tractor trailer trucks moving in reverse at loading docks or platforms.

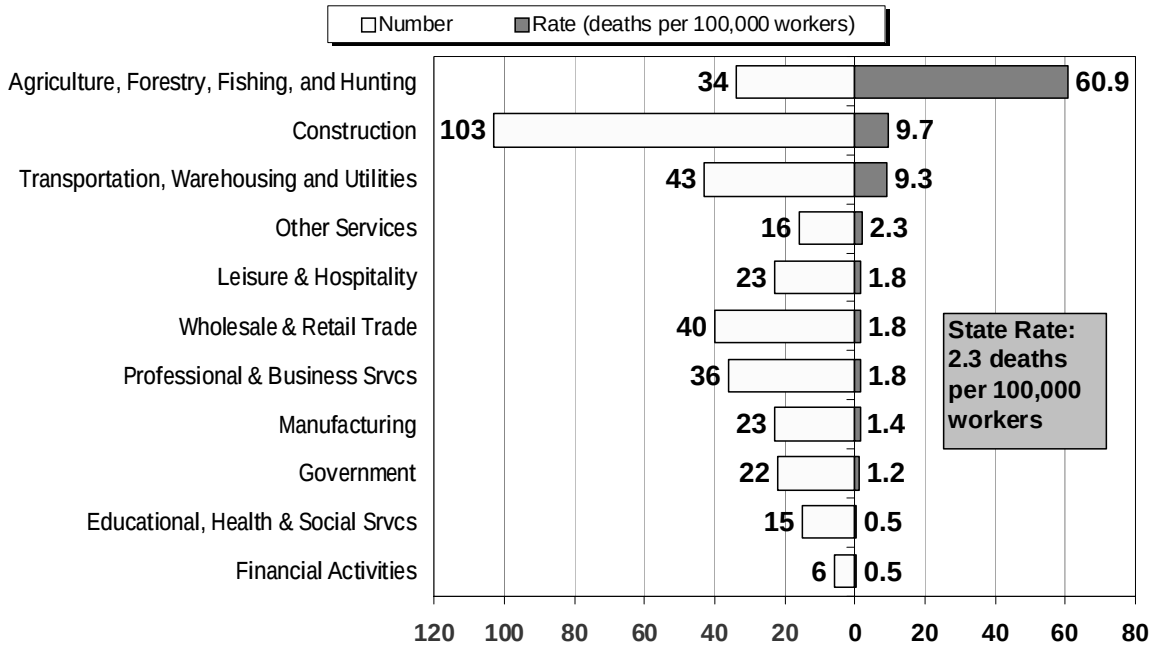
- Thirty-six (10%) of the workers fatally injured from 2003 through 2007 were employed in the **Professional & Business Services** sector. This is a broad industry sector that includes, company management, administrative/business support services, waste management /remediation, employment services, facilities services (e.g. landscaping, janitorial), and scientific and technical services. Nine of the victims in this industry sector were employed in landscaping, five of whom were fatally injured by falling objects (e.g. trees). Seven fatally injured workers were employed in janitorial services, five of whom fell to a lower level.

- In the **Manufacturing** sector, 23 workers were fatally injured at a rate of 1.2 deaths per 100,000 workers. Seven victims fell to lower levels, four were caught in running machinery, and another four were struck by falling objects (Table 4).

- Twenty-two workers employed in the **Government/Public** sector sustained fatal injuries, accounting for 6% of the deaths from 2003 through 2007. Thirteen of these victims held jobs in fire protection, public safety, and executive offices. The two leading events among government workers were highway motor vehicle incidents (5) and pedestrian (worker) being hit by a moving vehicle (4) (Table 4). (See Section 1.8 for a further discussion of the public sector fatalities.)

- The **Education, Health Care, and Social Services** sector, which employs about one-fifth of the Massachusetts workforce, had a low rate of fatal occupational injuries (0.5 deaths per 100,000 workers), yet had the highest number of suicides (5) compared with other industry sectors.

Chart 5. Number and Rate of Fatal Occupational Injuries *by Industry Sector*, Massachusetts, 2003-2007, N=364



NOTE: Information about industry was unavailable for 1 fatality. The Government sector includes fatalities sustained by public sector workers regardless of industry. Data not presented for two industry sectors with fewer than five fatalities (mining and information).

Municipal Police Officer Struck by Vehicle in Construction Work Zone

A municipal police officer was fatally injured when a motorist intruded into a roadway construction work zone. The victim had been standing inside the work zone at a four-way intersection directing traffic through a detour. The motorist, who failed to turn right at the detour, skidded sideways through traffic barrels and signs, striking the victim. The victim had been employed by the municipality for approximately three years. In Massachusetts, municipal police officers do not generally receive specific roadway construction work zone safety training.

To prevent similar incidents, MA FACE recommended that employers should: 1) ensure that work zones are setup, at a minimum, in accordance with the Manual on Uniform Traffic Control Devices (MUTCD), Part 6 developed by the U.S. Department of Transportation; 2) consider portable rumble strips to alert motorists to the modified roadway conditions; 3) consider area objects and the work site background when choosing colors for worker apparel; 4) local and state government agencies should consider work zone safety training for all municipal officers who perform traffic details on roadway construction sites; and 5) state government agencies should consider developing state laws that impose increased fines for motorists speeding within roadway work zones (MA FACE report 00MA054).

- As shown in Table 3 below, nine industries with the highest number of fatalities accounted for nearly one-third (32%) of all fatal occupational injuries in Massachusetts during the full eight-year period. Consistent with the findings for 2003–2007 discussed above, commercial fishing claimed more lives than any other single industry during the full eight year period.

Table 3. The Nine Industries with the Highest Numbers of Fatal Occupational Injuries, Massachusetts, 2000–2007

Detailed Industry	Number	% of Total Occupational Fatalities
Commercial Fishing	33	6.2
Freight Trucking	22	4.1
Building Contractor – Residential	21	3.9
Roofing/Siding Contractor	21	3.9
Eating and Drinking Places	18	3.4
Heavy Construction	16	3.0
Landscaping & Horticultural Services	14	2.6
Automotive Repair & Maintenance	14	2.6
Police Protection/Law Enforcement	12	2.2
Total	**171**	**31.9**

Table 4. Fatal Occupational Injuries: Leading Events and Industries within Industry Sectors, Massachusetts, 2003–2007

Industry Sector	Leading fatal events	Industries with three or more fatal occupational injuries
Agriculture, Forestry, Fishing & Hunting (34)	- Boat sunk/capsized (16) - Other water vehicle incident (8) - Fall from ship or boat (3)	Commercial fishing (29); crop farming (3)
Construction (103)	- Fall to lower level (49) - Electrocution (11) - Caught in or crushed by machinery or objects (6) - Struck by falling object (5) - Caught in or crushed by collapsing materials or structures (4) - Highway motor vehicle incident (4) - Fire or explosion (5) - Non-highway motor vehicle incident (3) - Carbon monoxide poisoning (3) - Worker struck by motor vehicle or mobile equip. (3) - Struck by object (3)	SPECIALTY TRADE CONTRACTOR (74) – Roofing or siding contractor (14); Other specialty trade contractors (11); Electrical contractor & other wiring installation contractor (8); Painting and wall covering contractor (8); Structural steel and precast concrete contractor (6); Site preparation contractor (6); Flooring and tile contractor (5); Masonry contractor (4); Poured concrete foundation & structure contractor (3); Framing contractor (3); Plumbing and HVAC contractor (3); Finish carpentry contractor (3); CONSTRUCTION OF BUILDINGS (19) - Residential building construction (16); Commercial and institutional building construction (3); HEAVY & CIVIL ENGINEERING CONSTRUCTION (9) – Power & communication line construction (4); Highway, street, bridge construction (3)
Transportation/ Warehousing & Utilities (43)	- Worker struck by motor vehicle or mobile equip. (9) - Aircraft crash (9) - Highway motor vehicle incident (8) - Fire or explosion (5) - Struck by object (3)	TRANSPORTATION/ WAREHOUSING: General freight trucking (8); Specialized freight trucking (6); Passenger air transportation (6); Couriers & express delivery services (4); Commuter rail systems (3); taxi service (3); Navigational services to shipping (3) UTILITIES: Electric power generation, transmission, distribution (4)
Other Services (16)	- Worker struck by motor vehicle or mobile equip. (5) - Struck by object (3)	General automotive repair (6); Automotive body, paint, & interior repair and maintenance (4)
Leisure & Hospitality (23)	- Homicide (11) - Suicide/self-inflicted injury (3)	Food services and drinking places (12); Hotels and motels (5); Amusement, sports and recreational industries (6)
Wholesale and Retail Trade (40)	- Homicide (10) - Worker struck by motor vehicle or mobile equip. (6) - Highway motor vehicle incident (4) - Fall to lower level (4) - Struck by object (4) - Fall on same level (3) - Suicide/self-inflicted injury (3)	WHOLESALE: Merchant wholesaler – durable goods (8); Grocery & related product merchant wholesaler (5) RETAIL: Building material & supplies dealer (5); Grocery/ convenience store(5); Gasoline stations (7)
Professional & Business Services (36)	- Fall to lower level (7) - Highway motor vehicle incident (5) - Struck by falling object (5) - Aircraft crash (4) - Suicide/self-inflicted injury (4) - Caught in running machinery or equip.(3)	Landscaping services (9); Janitorial services (7); Waste management and remediation services (6); Other professional, scientific and technical services (4);Offices of lawyers (3)
Manufacturing (23)	- Fall to lower level (7) - Caught in running machinery or equip.(4) - Struck by falling object (4)	Nonmetallic mineral product manufacturing (4); Fabricated metal product manufacturing (4); Food or beverage manufacturing (3); Computer & electronic product manufacturing (3)
Government Sector (22)	- Highway motor vehicle incident (5) - Worker struck by motor vehicle or mobile equip. (4) - Exposure to biologics or chemicals/drugs (3) - Fire or explosion (3)	Police protection (6); Fire protection (5)
Educational & Health Services (15)	- Suicide/self-inflicted injury (5)	General medical & surgical hospital (6); College, universities, or professional school (4)
Financial Activities (6)		Real estate, rental, leasing (4)

Fatal Injuries among Brazilian Workers in Massachusetts

Brazilian workers are the most populous newcomer group in Massachusetts post 1990.[24] From 2000 to 2003, almost one out of every five immigrants entering Massachusetts was from Brazil.[25] From 1991, when the Massachusetts Department of Public Health first began tracking fatal occupational injuries, through 1999, the death of one worker born in Brazil was recorded. From 2000 through 2007, 17 workers born in Brazil were fatally injured at work in Massachusetts.[26] All were male and more than two-thirds (12) of these men worked in construction. Falls to lower levels accounted for six of the Brazilian construction worker deaths.

For more information, refer to *Fatal Work Injuries among Brazilians in Massachusetts 1999–2007* at www.mass.gov/Eeohhs2/docs/dph/occupational_health/brazilian_fatalities.pdf and *Project PARCERIA/COBWEB: A Report on Brazilian Immigrant Workers in Massachusetts* at http://drupal.masscosh.org/files/COBWEB%20report%20final-%20low%20resolution.pdf

1.7 Occupation [27]

- From 2003 through 2007, workers in **Farming, Fishing, and Forestry** occupations had the highest fatal occupational injury rate (78.2 deaths per 100,000 workers) – about 34 times higher than the overall rate for the state (Chart 6). All but four fatally injured workers in this group were commercial fishing workers who died in 15 incidents (Table 5). Six of the 15 fishing incidents involved boats sinking or capsizing, and resulted in as many as five deaths per incident. The fatality rate for fishing occupations alone for the eight-year period 2000 – 2007 was 174.0 deaths per 100,000 workers – approximately 82 times higher than the overall fatality rate for the state. Massachusetts ranked second following only Alaska in the number of commercial fishing deaths during this eight year period.[28] The exceptionally high rate of fatalities among commercial fishers is consistent with previous findings in Massachusetts as well as national findings.[16, 29]

- The **Construction and Extraction** group had the highest number of occupational fatalities (27.7%; N=101) and one of the highest rates (11.3 deaths per 100,000 workers) – almost five times higher than the overall rate for the state during the five-year period 2003 – 2007 (Chart 6). Forty-eight percent of all fatal falls to lower levels and 55% of all fatal electrocutions involved workers in this group. The occupations in this group with the greatest number of deaths were carpenters (19), construction laborers (14), roofers (13) and electricians (12) (Table 5).

- **Transportation and Material Moving** occupations were second to construction and extraction in terms of the numbers of deaths (21.6%; N=79) during 2003 through 2007 (Chart 6). This group also had one of the highest rates of fatal occupational injuries (10.9 deaths per 100,000 workers) – more than four-and-a half times higher than the overall rate for the state during 2003 through 2007. About

[24] Siqueira, Carlos E. and de Lourenco, Cileine. Brazilians in Massachusetts: Migration, Identity, and Work. Latinos in New England. Edited by Andres Torres, Philadelphia: Temple University Press, pp. 187-201, 2006.

[25] The Changing Face of Massachusetts, The Massachusetts Institute for a New Commonwealth (MassINC) and The Center for Labor Market Studies, June 2005, Accessed at http://www.massinc.org/fileadmin/researchreports/changingface/changing_face_report.pdf

[26] This number differs slightly from the number reported previously due to inclusion of suicides in the present count and the identification of two additional deaths of Brazilians that had not been confirmed at the time the earlier report was published.

[27] With the exception of Table 6, findings by occupation in this section cover ONLY 2003 – 2007 due to changes in the occupation classification systems between 2002 and 2003 (discussed previously) that preclude precise comparisons between fatal occupational injury data (pre -2003) and the more current data (2003 – 2007).

[28] Census of Fatal Occupational Injuries, U.S. Department of Labor, Bureau of Labor Statistics, Profiles query, http://data.bls.gov/GQT/servlet/InitialPage 2000–2007.

[29] Centers for Disease Control and Prevention (CDC). Commercial Fishing Fatalities – California, Oregon, and Washington 2000–2006. Morbidity and Mortality Weekly Report (MMWR) 2008; 57:425-429.

one-half of these deaths (49.4%; N=39) involved either a motor vehicle crash or a worker being struck by a motorized vehicle on or off the roadway (Table 5). During this period, truck driving claimed more lives than any other single occupation, accounting for 8.8% of all fatalities (Table 5).

Iron Worker Crushed by Collapsing Boom

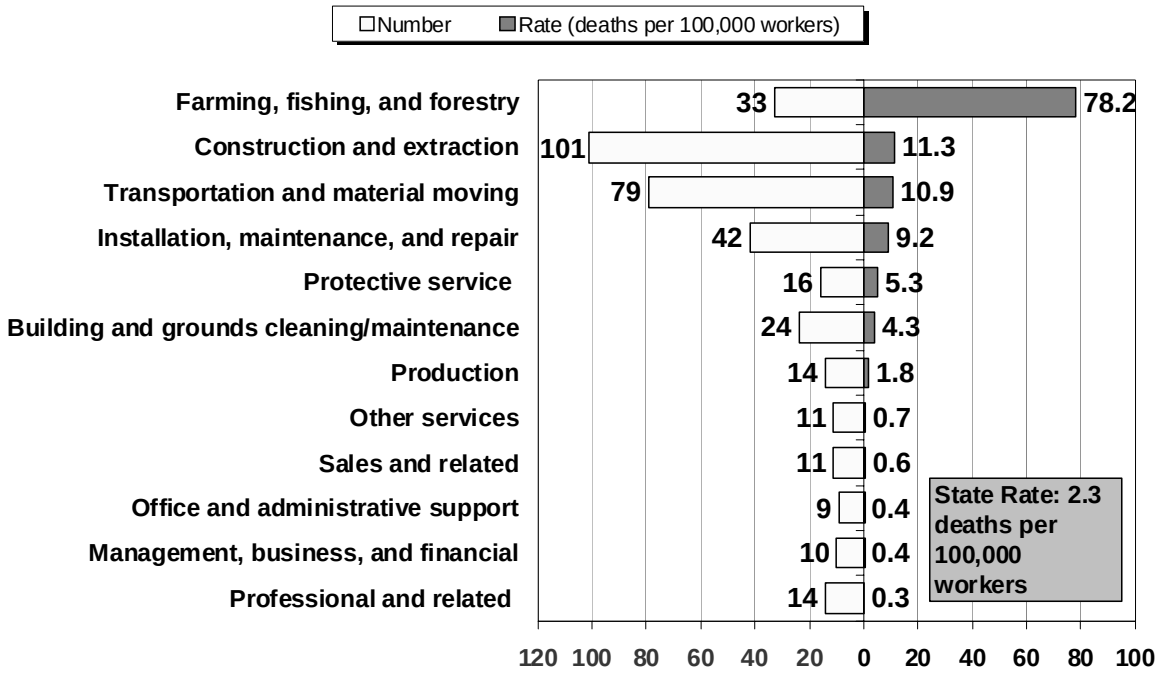
A 52-year-old male iron worker was fatally injured when a lift's telescopic boom collapsed, crushing him. The victim was working with a co-worker to replace one of the lift's counterbalance valves. At the time of the incident, the lift's boom was in an extended position. The victim had just removed the counterbalance valve when the boom collapsed, crushing him against the lift's base.

To prevent similar incidents, MA FACE recommended that employers should: 1) ensure that when hydraulic boom lifts are being worked on, the booms are either in the stowed position or adequately supported; 2) ensure that only qualified repair personnel conduct maintenance on equipment; 3) routinely conduct a job safety analysis to ensure proper practices and procedures are implemented; 4) develop, implement, and enforce a hazardous energy control program, including lockout/tagout procedures.

In addition, manufacturers of machine components should: 1) consider including hazard warnings inside the packaging of hydraulic system components (MA FACE report 07MA045).

- **Installation, Maintenance, and Repair** workers had the third highest number of occupational fatalities (11.5%; N=42) and a fatality rate four times higher than the overall state rate for the five-year period 2003–2007 (Chart 6). Eight of these victims were automotive/auto body repairers who died in a variety of events; three were caught under automobiles that had shifted off their supports and another three were struck by vehicles (Table 5). Eight workers in this occupational group were installers or repairers of electrical power line and/or telecommunication equipment, four of whom were electrocuted when the utility buckets they were in or materials they were installing become electrified by overhead power lines (Table 5).

Chart 6. Number and Rate of Fatal Occupational Injuries *by Occupation Group* , Massachusetts, 2003-2007, N=364



NOTE: Information about occupation was unavailable for 1 fatality.

Table 5. Fatal Occupational Injuries: Leading Events and Occupations within Occupational Groups, Massachusetts, 2003–2007

Occupational group	Leading fatal events	Occupations with three or more fatal occupational injuries
Farming, Fishing, & Forestry (33)	- Boat sunk/capsized (16) - Other water vehicle incident (8) - Fall from ship or boat (3)	Fishers & related fishing workers (29); Farm workers & laborers (3)
Construction & Extraction(101)	- Fall to lower level (48) - Electrocution (11) - Caught in or compressed by machinery, equipment or other objects (6) - Struck by falling object (6) - Caught in or crushed by collapsing materials or structures (6) - Fire or explosion (4) - Worker struck by motor vehicle or mobile equip. (4) - Non-highway motor vehicle incident (3) - Suicide/self-inflicted injury (3) - Carbon monoxide poisoning (3)	Carpenters (19); Construction laborers (14); Roofers (13); Electricians (12); Structural iron & steel workers (8); Painters, construction, and maintenance (8); Paving, surfacing, and tamping equip. operators (3); Hazardous materials removal workers (3) First –line supervisors/managers (3); Floor sanders & finishers (3)
Transportation & Material Moving (79)	- Highway motor vehicle incident (19) - Worker struck by motor vehicle or mobile equip. (16) - Aircraft crash (9) - Homicide (6) - Struck by rolling or sliding objects not in normal operation (6) - Struck by falling object (5) - Non-highway motor vehicle incident (4) - Caught in or compressed by machinery or objects (4) - Fall to lower level (3)	Truck drivers, heavy & tractor-trailer (32); Industrial truck & tractor operators (7); Laborers & material movers (7); Commercial pilots (5); Service station attendants (4); Driver/sales workers (4); Taxi drivers & chauffeurs (4); Airline pilots, copilots, & flight engineers (3); Rail transportation workers (3)
Installation, Maintenance, and Repair (42)	- Fall to lower level (9) - Electrocution (5) - Worker struck by motor vehicle or mobile equip. (4) - Caught in or compressed by machinery, equipment or other objects (3) - Exposure to caustic, noxious, or allergenic substance (3) - Fall on same level (3) - Struck by falling object (3) - Other struck by object (3) - Fire or explosion (3)	Automotive/auto body repairers (8); Telecommunications line installers & repairers (5); Maintenance & repair workers (general) (4); Mobile heavy equipment mechanics (3); Industrial machinery mechanics (3); Machinery maintenance workers (3); Electrical power-line installers & repairers (3)
Protective Service (16)	- Highway motor vehicle incident (5) - Homicide (3) - Suicide/self-inflicted injury (3) - Fire or explosion (3)	Police officers & detectives (7); Firefighters (5); Security guards (4)
Building and Grounds Cleaning/Maintenance (24)	- Fall to lower level (8) - Struck by falling object (5)	Janitors & cleaners (8); Landscaping & grounds keeping workers (7); Tree trimmers & pruners (5) Maids & housekeeping workers (3)
Production (14)	- Fire or explosion (6) - Caught in running equipment or machinery (4)	Welders, cutters, & solderers (4)
Other Services (11)	- Homicide (3) - Suicide/self-inflicted injury (3)	Personal service & care workers (tour/travel guides, ushers, recreation workers) (4); First-line supervisors – food preparation & serving (3); Waiters & waitresses (3)
Sales and Related (11)	- Homicide (8)	Cashiers & retail sales workers (7); First-line supervisors – sales workers (4)
Office & Administrative Support (9)	- Worker struck by motor vehicle or mobile equip (3) - Suicide/self-inflicted injury (3)	Material recording, scheduling, dispatching, and distributing workers (4); medical admin. assistants (3)
Management, Business, and Financial (10)	- Highway or non-highway motor vehicle incident (3)	Management (7); Business & financial operations (3)
Professional and Related (14)	- Suicide/self-inflicted injury (4) - Aircraft crash (3)	Arts, design, entertainment, sports, & media workers (5)

- As shown in Table 6 below, six occupations with the highest number of fatalities accounted for nearly one-third (31%) of all occupational fatalities in Massachusetts during the full eight-year period. Consistent with findings for 2003–2007 discussed above, truck driving claimed more lives than any other single occupation during the full eight year period (Table 6).

Table 6. The Six Occupations with the Highest Number of Fatal Occupational Injuries, Massachusetts, 2000–2007

Detailed Occupation	Number	% of Total Occupational Fatalities
Truck drivers	42	7.9
Fishers	34	6.4
Construction laborers	27	5.1
Carpenters	23	4.3
Roofers	20	3.7
Electricians	18	3.4
Total	**164**	**30.7**

1.8 Government Workers

- From 2000 through 2007, 40 public sector employees were fatally injured at work accounting for 7.5% of the work-related deaths. Sixty percent (24) of public sector victims worked for local/municipal government, 27.5% (11) worked in state government, and the remaining 12.5% (5) were federal government employees. Deaths of public sector workers raise special concerns because these workers are not protected under the federal Occupational Safety and Health Act in Massachusetts.
- For the eight-year period 2000–2007, the fatal occupational injury rate for government workers (1.2 deaths per 100,000 workers) was about one-half the rate for all workers (2.1 deaths per 100,000 workers).
- Nine workers were fatally injured after being struck by vehicles, and seven workers were drivers or occupants of vehicles involved in fatal highway incidents. Suicide, fall from height, fire/explosion, exposure to biologics or chemicals/drugs, and other events accounted for the remaining 24 fatalities.
- Government workers who died from work-related injuries were employed in a wide range of industries. Almost two-thirds (65%; N=26) of these 40 workers were employed in public administration, including law enforcement/public safety (13), fire protection (6), and executive/administrative programs or agencies (7). Four fatalities occurred in the passenger transit industry; an additional four occurred in educational settings.

Municipal Utility Worker Crushed against Backhoe Bucket by Vehicle

A 39-year-old municipal utility worker was fatally injured while patching a pothole located on the edge of a roadway in a residential area at night. The victim, who was working alone, was standing in front of a backhoe filling the pothole when a minivan struck him, crushing him against the backhoe bucket. No work zone traffic control devices were in place, and the victim was not wearing high visibility clothing. The victim had been employed by the municipality for 14 years. The employer had neither a health and safety program nor an individual specifically in charge of health and safety.

To prevent similar incidents MA FACE recommendations included that municipalities should: 1) ensure that work zones are set up, at a minimum, in accordance with the Manual on Uniform Traffic Control Devices (MUTCD), Part 6; 2) ensure that employees' exposure to moving traffic is minimized by developing temporary traffic control plans; 3) provide and ensure that employees wear appropriate personal protective equipment, including high visibility vests, when working along roadways; 4) develop, implement, and enforce a safety program that includes a buddy system provision for employees working in roadways and around moving equipment; 5) provide work environments that, at a minimum, meet all relevant OSHA regulations and industry accepted standards of practice;. (MA FACE report 06MA027).

1.9 Self-employed Workers

- Of the 535 workers who were fatally injured from 2000 through 2007, 17% (93) were self-employed. However, self-employed workers accounted for, on average, only 7% of the Massachusetts workforce during this period.[30]

- The fatal occupational injury rate for self-employed workers (5.3 deaths per 100,000 workers) was almost three times higher than the rate for wage and salary workers (1.8 deaths per 100,000 workers). This disparity in rates is likely explained, in part, by the disproportionate concentration of self-employed workers in high risk industries compared with wage and salary workers. Proportionately more self-employed workers (22%) than wage and salary workers (6%) were employed in construction, a high hazard industry. [31]

- The majority of fatal injuries among self-employed workers occurred in high risk industries and occupations. For example, 62% (58) of fatalities among self-employed workers occurred in three industry sectors: Construction, Agriculture, Forestry & Fishing, and Services (landscaping, janitorial, auto repair). The leading occupations of the self-employed victims were carpenters, farm workers, managers/administrators, roofers, tree trimmers/landscape workers, commercial fishers, painters, and sales workers/cashiers.

1.10 Foreign-Born Workers

- Approximately one in five (21.1%; N=113) workers fatally injured at work during 2000–2007 was born outside of the United States. However, foreign-born workers accounted for, on average, only 16% of the Massachusetts workforce during this period. [27]

- The rate of fatal occupational injury among foreign-born workers (2.7 deaths per 100,000) was higher than the rate for U.S.-born workers (1.9 deaths per 100,000).

- The Construction industry, a high-risk industry, accounted for the greatest percentage (34.5%; N=39) of fatalities among foreign-born workers, and foreign-born workers in this industry had a fatal occupational injury rate (13.6 deaths per 100,000 workers) that was almost two times higher than the rate for U.S.-born construction workers (7.5 deaths per 100,000 workers).
- Correspondingly, more than one-third (36.3%, N=41) of the foreign-born victims were employed in Construction occupations (including laborers). Of these construction workers, 29.3% were construction laborers, 19.5% were roofers, and 14.6% were carpenters. The majority of the remaining fatalities were among other non-construction laborers (freight/stock handlers), commercial fishers, janitors and other cleaners, truck drivers, sales workers/cashiers, landscapers/groundskeepers, and taxi drivers.

- The single leading event among both foreign-born and U.S.-born workers was the same: Fall to a lower level, accounting for 21.2% and 18.3% of fatalities in the respective groups. However, workplace homicide accounted for a greater percentage of fatal occupational injuries among foreign-born workers (15.9%; N=18) than among U.S.-born workers (7.5%; N=31). This finding may be explained, in part, by the disproportionate employment of foreign-born workers in cash-handling occupations in service/gas stations, retail, and passenger transport (e.g. bus drivers, taxi drivers). Additionally, the rate of workplace homicide among foreign-born workers (0.43 deaths per 100,000 workers) was three times higher than the rate among U.S.-born workers (0.14 deaths per 100,000 workers).

[30] U.S. Census Bureau, DataFerrett, Current Population Survey data, 2000–2007, February 2009.
[31] U.S. Census Bureau, DataFerrett, Current Population Survey data, 2003–2007 (average annual), February 2009.

Immigrant Worker Crushed Inside a Paper Baler

A 22-year-old immigrant laborer from Guatemala was fatally crushed while inside a horizontal paper baler. The victim entered the baler's hopper to manually clear a jammed paper bale because the baler's jam clearing mechanism had not been working. While he was crouched between the ram and the jammed paper bale, the ram cycled in the forward direction crushing him. He had been employed with the company for four years and his training was primarily on-the-job, which did not include training on the hazards associated with his death.

To prevent similar incidents, MA FACE recommended that employers should: 1) ensure that machines are operating properly to eliminate potential hazards to employees; 2) develop and enforce a hazardous energy control program for all employees including specific lockout/tagout procedures for each machine; 3) develop a training program that includes a protocol on how to clear jams and ensure that all workers are trained in the safe operation of each machine including the potential hazards; and 4) develop, implement, and enforce a health and safety program (MA FACE report 00MA035).

1.11 Employer Establishment Size

- Of the 482 fatal occupational injuries during 2000–2007 for which employers' establishment size information was available, the majority (55%; N=265) occurred in establishments with 19 or fewer employees. These small establishments also experienced the highest fatal occupational injury rate (3.3 deaths per 100,000 workers) – about twice the rate for establishments of all sizes (1.6 deaths per 100,000 workers) (Chart 7).

- Most – four out of five – of the 265 victims employed in these small establishments (19 or fewer employees) were actually working for employers with 10 or fewer employees, the largest proportion of whom were working in the Construction industry at the time of their death (37.4%; N=82) followed by Agriculture, Forestry, and Fishing (15.1%; N=33) and Retail Trade (10.5%; N=23).

- Self-employed workers (including workers in family businesses) accounted for 37% (81) of fatal injuries in the smallest establishments (10 or fewer employees) while they accounted for only 17% of all fatal occupational injuries.

- Additionally, the smallest companies/firms (10 or fewer employees) had a higher proportion of Hispanic victims (13.7%; N=30) than the larger establishments combined (8.4%; N=22). Also, 11 of the 17 victims born in Brazil were working in the smallest establishments (10 or fewer employees). This finding is consistent with the types of businesses in which, according to one study, the majority of Brazilian immigrants in Massachusetts are most likely to work: cleaning services/housecleaning and construction, both of which tend to be small business ventures with very few employees.[32]

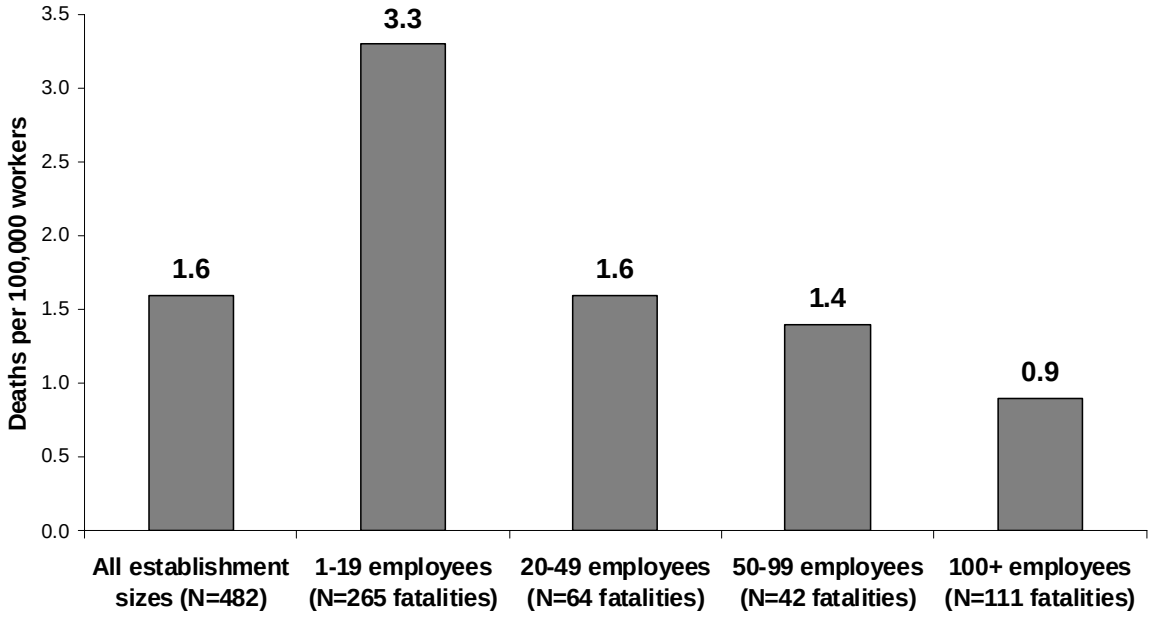
1.12 Distribution of Occupational Fatalities by County

- The number of fatal occupational injuries varied by county ranging from 5 fatalities in Franklin County to 105 in Middlesex County (Table 7).

- Four counties, namely, Middlesex, Suffolk, Worcester, and Bristol accounted for over half (54%; N=283) of the total occupational fatalities in the state during the 8-year period.

[32] Siqueira C, Barbosa, A, A Report on Brazilian Immigrant Workers in Massachusetts, Project PARCERIA/COBWEB (Collaboration for Better Work Environment for Brazilians), Chapter 3:p.9., 2009. Accessed at http://drupal.masscosh.org/files/COBWEB%20report%20final-%20low%20resolution.pdf

Chart 7: Rate of Fatal Occupational Injuries *by Establishment Size* (number of employees), Massachusetts, 2000-2007



NOTE: Rates calculated using 2004 employment data from the March supplement of the Massachusetts Employment & Wage Program (ES-202), Executive Office of Labor and Workforce Development. These data include all establishments and their employees in Massachusetts subject to state and federal unemployment compensation laws. In computing rates, fatalities among self-employed workers (N=76) were excluded in order to maintain consistency with the denominator (employment) data. Establishment size information was not available for 53 fatalities.

Table 7. Fatal Occupational Injuries by Location of Incident, Massachusetts, 2000 – 2007

County	Number	Percent of fatal occupational injuries
Nantucket	17	6.6
Barnstable	29	5.5
Suffolk	74	14.0
Berkshire	13	2.5
Bristol	49	9.3
Hampden	40	7.6
Plymouth	40	7.6
Franklin	5	0.9
Norfolk	46	8.7
Middlesex	105	19.9
Worcester	55	10.4
Essex	40	7.6
Hampshire	9	1.7
Dukes	6	1.1
All Counties	**528**	**100**

NOTE: County of fatal incident was unknown or missing for seven fatalities.

Hispanic Worker Fatally Injured While Wheel Harrowing a Tobacco Field

A 64-year-old Hispanic seasonal worker was decapitated while operating a tractor that was pulling a wheel harrow on a tobacco field. The tobacco field was completely covered with shade tents (netting) supported by grid wires and wood poles. The employer had modified the tractor with a homemade wire guard designed to push any low hanging grid wires out of the operator's way. The victim was operating the tractor and as he exited a shade tent, his neck came in contact with one of the tent's grid wires forcing him back against the rear of the tractor's wire guard, decapitating him.

To prevent similar incidents MA FACE recommended that employers should: 1) ensure manufacturers review tractor modifications and make sure that the modifications do not create additional hazards; 2) select appropriate sized tractors that fit underneath shade tents; 3) conduct routine shade tent inspections ensuring there are no low hanging wires; and 4) ensure that tractor operators are trained on the safe use and operation of tractors (MA FACE report 01MA016).

1.13 Fatal Occupational Injuries Inspected by OSHA

The Occupational Safety and Health Administration (OSHA) conducts investigations of workplace fatalities to determine if safety standards have been violated. However, fatalities that occur under certain circumstances/events (e.g. airplane and railway crashes) fall outside of OSHA jurisdiction[33] as do fatalities among workers in some industries and workforce groups (e.g. mine workers, commercial fishing workers at sea, public sector employees in many states including Massachusetts, sole proprietors, and the self-employed). Also, certain types of fatalities (such as homicides, suicides, and roadway motor vehicle-related incidents) are not routinely inspected or addressed by OSHA. In addition, OSHA no longer conducts fatality investigations when the death occurs more than 30 days after the injury event.

Out of the total 535 fatal occupational injuries, OSHA inspected 211 (39.4%) fatalities. The remaining 324 fatalities were not inspected because; a) they did not fall under OSHA's jurisdiction b) they resulted from events that are not routinely inspected by the agency or c) the fatalities occurred more than 30 days after the injury. These included 175 occupational fatalities that resulted from airplane crashes or trains/other equipment striking workers on railroad tracks or occurred among self-employed workers, commercial fishers, and government workers. They also included 130 occupational fatalities due to homicide, suicide, or motor vehicle-related incidents.

In addition to OSHA's enforcement inspections, the Massachusetts Department of Public Health conducted research-oriented investigations of approximately 80 occupational fatalities between 2000 and 2007 as part of the national Fatality Assessment and Control Evaluation (FACE) Program. The events covered in these investigations include, but are not limited to the following: teen worker deaths, public sector worker deaths, falls to a lower level, machine-related incidents, electrocutions, explosions, and highway work zone incidents. Summaries of select FACE investigations in Massachusetts with prevention recommendations are included throughout this report.

[33] OSHA's jurisdiction may depend on the precise nature or circumstances of the incident. Other agencies such as the Mine Safety & Health Administration (MSHA), the Federal Railroad Administration (FRA), the Federal Aviation Administration (FAA), and the Coast Guard protect the health and safety of workers under their respective jurisdiction.

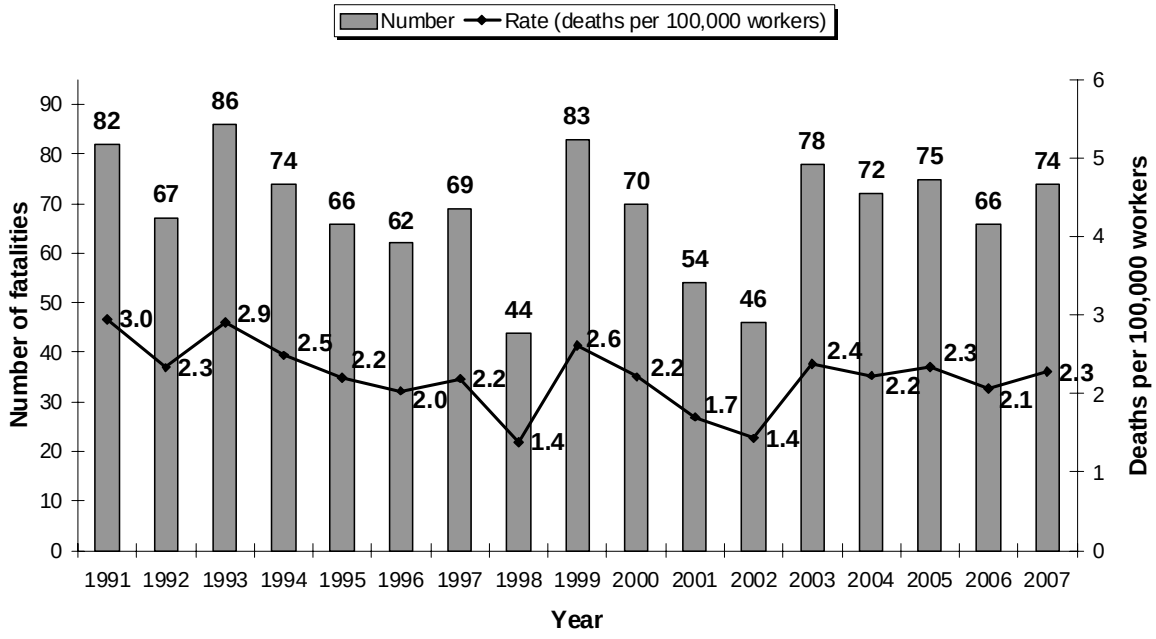
II. Fatal Occupational Injury Experience in Massachusetts: Comparison of Two Surveillance Periods, 1991–1999 and 2000–2007

Massachusetts Department of Public Health began collecting data on fatal occupational injuries in 1991. In this section, data on fatal occupational injuries in Massachusetts from 2000–2007 are compared with findings from the previous surveillance period (1991–1999).[16]

2.1 *Magnitude of the Problem*

- The number of fatal occupational injuries and the fatality rate fluctuated from year to year, with both the highest and lowest number of deaths in any year occurring in the 1991–1999 time period. There was no consistent upward or downward trend in either the numbers or rates of fatal occupational injuries over the 17-year period (Chart 8).

Chart 8. Number and Rate of Fatal Occupational Injuries *by Year,* Massachusetts, 1991-2007 (N=1,168)



2.2 *Sex and Age*

- The distributions of deaths by sex and age were similar in both surveillance periods. In both periods, the majority of victims (93%) were male and the average age at death was 43 years. While workers 65 years of age or older comprised about seven percent of the victims in both time periods, the average annual fatality rate for this older age group decreased from 6.6 per 100,000 in 1991–1999 to 3.4 per 100,000 in 2000–2007. This decrease in the fatality rate did not appear to be explained by differences in the occupational distribution of the older workforce between these two time periods.[34]

[34] U.S. Census Bureau, DataFerrett, Current Population Survey data, 1991–2007, March 2009.

2.3 *Race and Ethnicity*

- The distribution of deaths by race and ethnicity shifted over the two time periods. As the number of Hispanic workers has increased in the Commonwealth, the number of deaths to Hispanic workers has also increased. Hispanic workers accounted for 5% of the deaths in 1991–1999 and 10% of the deaths in the more recent surveillance period. The Hispanic workforce also increased, from 3.2% of the total workforce in 1990 to 6.5% in 2007.[35] The fatal occupational injury rates for Hispanic workers were similar for both surveillance periods – approximately three deaths per 100,000 workers. In both periods, the rate for Hispanic workers was about 50% higher than the rate for White non-Hispanic workers.[36]

- The leading cause of death among Hispanics during1991–1999 was homicide (31%) and during 2000 – 2007 was falls to a lower level (28%). Homicide accounted for 13% (7) of the Hispanic worker deaths during 2000–2007.

- During the previous surveillance period, 9% (3) of the Hispanic victims were employed in construction compared to 31% (17) during the more recent surveillance period.

2.4 *Fatal Event/Exposure*

- The distribution of fatalities as well as the rates by type of event/exposure remained constant over the two time periods with the leading event categories being transportation incidents, followed by falls, and contact with objects or equipment. In both time periods, a fall to a lower level was the single leading event.

2.5 *Industry and Occupation*

As mentioned previously, there were changes in industry and occupation classification systems introduced in 2003. These changes precluded precise comparisons of industry and occupation findings between the two surveillance periods. However, several important findings remained consistent over time.

- During both surveillance periods, fishermen (occupation: Fisher and Related Worker) stand out as having an exceptionally high fatality rate. The fatality rate for fishing occupations alone for the eight-year period 2000–2007 was 174.0 deaths per 100,000 workers – approximately 82 times higher than the overall fatality rate for the state.

- The Construction industry had high numbers and rates of fatal occupational injuries during both surveillance periods. The fatality rate for construction workers during 1991–1999 (10.9 deaths per 100,000 workers) was somewhat higher than the fatality rate for construction workers during the 2000–2007 period (8.5 deaths per 100,000 workers) but this difference was not statistically significant. The fatal occupational injury rate for construction was more than four times the overall rate for the state in both periods. Close to one-half (50.5%; N=143) of the deaths in the Construction industry were due to falls over the full 17 year period (1991–2007).

- Fishers, truck drivers and construction laborers were the three leading occupations of the victims during both time periods.

[35] Ruggles S, Sobek M, Alexander T, Fitch C et al., Integrated Public Use Microdata Series version 4.0, Minneapolis, MN: Minnesota Population Center, 2009, Massachusetts 1990 IPUMS 5% data & Massachusetts 2007 American Community Survey data accessed at http://usa.ipums.org/usa.

[36] In the 1991–1999 surveillance period, Hispanic workers were compared to White workers of both Hispanic and non-Hispanic origins.

2.6 *Self-employed Workers*

- The percent of fatally injured workers who were self employed increased from 11% in 1991–1999 to 17% in the 2000–2007 time period. This increase does not appear to be explained by an increase in the percent of the Massachusetts workforce that was self-employed, which changed only slightly from 5.2% of the total workforce in 1990 to 5.9% in 2007.[35] The fatality rate for the self employed was slightly higher during 2000–2007 (5.3 deaths per 100,000 workers) than the rate for the earlier surveillance period (4.4. deaths per 100,000 workers) but this difference was not statistically significant. In both time periods, the largest proportion of self-employed victims was employed in construction.

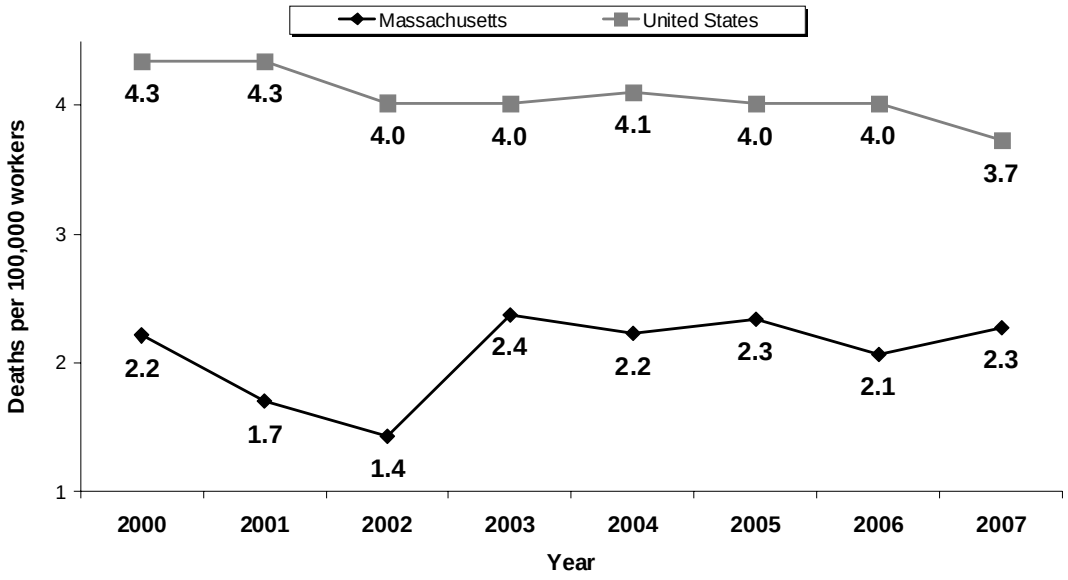
III. Comparison of Massachusetts and the U.S.

In this section, CFOI data on fatal occupational injuries in Massachusetts during 2000–2007 are compared with CFOI findings for the nation as a whole.

3.1 *Rates of Fatal Occupational Injury*

- Massachusetts compares favorably to the nation in terms of many different health outcomes and the fatal occupational injury experience is no exception. During 2000–2007, close to 6,000 workers were fatally injured on the job annually in the United States. Each year during this time period, Massachusetts had a lower fatal occupational injury rate than the nation (Chart 9). In most years, the state rate was approximately half that of the nation.

Chart 9. Rate of Fatal Occupational Injuries *by Year*, Massachusetts (N=535) & United States (N=45,770), 2000-2007



- This difference in fatality rates was likely explained in part by differences in the industrial composition of the Massachusetts workforce as compared with that of the nation. For example, 28% of the Massachusetts workforce was employed in Education, Health & Social Services, and Financial Services during 2003–2007 as compared to 21% of the U.S. workforce (Table 8). Nationwide, more workers were employed in higher risk industry sectors such as Agriculture, Forestry, Fishing, & Hunting, Mining, Construction, Transportation, Warehousing & Utilities, and heavy Manufacturing (Table 8).

- Most industry-specific fatality rates for 2003–2007 were lower in Massachusetts than in the nation as a whole (Table 8). National fatality rates for the Transportation, Warehousing & Utilities, Manufacturing, Professional & Business Services, and Education, Health & Social Services sectors were more than 50% higher than the Massachusetts' rates for these industry sectors. The U.S. fatality rates for both Financial Services and Government (public sector) were more than twice the rates for these industry sectors in Massachusetts. The U.S. rate for the Agriculture & Forestry industry sub-sector was more than four times the rate for Agriculture & Forestry in Massachusetts.

Table 8. Percent of Workforce and Percent & Rate of Fatal Occupational Injuries, *by Industry Sector*, Massachusetts and the United States

	Massachusetts, 2003–2007			U.S., 2003–2007		
Industry Sector	% of Workforce (5 Year Average)	% of Fatalities (5 Year Average)	Fatality Rate	% of Workforce (5 Year Average)	% of Fatalities (5 Year Average)	Fatality Rate
Agriculture, Forestry, Fishing & Hunting	0.3	9.0	60.9	1.5	11.7	30.8
Agriculture & Forestry			*11.2*			*48.4*
Fishing, Hunting, Trapping			*224.4*			*88.0*
Mining	0.1	- -	- -	0.4	2.9	26.6
Construction	6.6	27.4	9.7	7.6	21.1	11.1
Transportation, Warehousing, & Utilities	2.9	11.4	9.3	4.1	15.6	15.2
Other Services	4.4	4.3	2.3	4.9	3.4	2.7
Leisure & Hospitality	7.8	6.1	1.8	8.2	4.4	2.1
Wholesale & Retail Trade	13.9	10.6	1.8	14.8	10.0	2.7
Professional & Business Services	12.5	9.6	1.8	10.0	8.2	3.2
Manufacturing	9.9	6.1	1.4	11.6	7.5	2.6
Education, Health, & Social Services	19.8	4.0	0.5	13.5	2.7	0.8
Financial Services	7.9	1.6	0.5	7.1	2.1	1.2
Information	2.3	0.8	*	2.4	1.2	1.9
Government	11.5	5.9	1.2	13.9	9.3	2.6
Total	*100*	*100*	*2.3*	*100*	*100*	*4.0*

NOTES: Employment estimates from the Current Population Survey were used to compute percent of workforce and fatality rates. Dashes indicate no fatal injuries within that industry sector during this time period.
Rates are expressed as the number of fatal occupational injuries per 100,000 Massachusetts workers.
* Rate not presented due to small number of fatal injuries (fewer than 5).
SOURCE for national data: Census of Fatal Occupational Injuries (CFOI), Bureau of Labor Statistics, U.S. Department of Labor, 2000 – 2007.

- Notably, the rate for the Fishing, Hunting, and Trapping industry sub-sector in Massachusetts was substantially higher than the national rate for this industry sub-sector (Table 8).

- An industry-adjusted average annual fatality rate[37] for Massachusetts for 2003–2007 was calculated to determine how much of the difference in rates could be explained by the difference in industry makeup of the Massachusetts workforce as compared with that of the U.S. workforce. The overall industry-adjusted fatality rate for Massachusetts was 3.2 fatalities per 100,000, still lower than but closer to the national rate of 4.0 fatalities per 100,000 workers. State and national differences in workforce composition *within* industry sectors were not accounted for and could also contribute to the differences between state and national rates. These findings, however, do suggest that the difference in industrial composition of the workforce between Massachusetts and the nation can explain much, but not all, of the observed rate difference.

- Another explanation for the lower fatal occupational injury rates in Massachusetts is that homicide and highway motor vehicle-related fatalities, two events that contribute substantially to the occupational fatality burden, are low in the Massachusetts general population compared to the

[37] This rate was standardized by the direct method to the 2003–2007 industrial composition of the nation.

nation. The average annual crude homicide rate in the general Massachusetts population for the six-year period between 2000 and 2005 was 2.7 fatalities per 100,000 population while the comparable rate for the nation was 6.2 fatalities per 100,000 population.[38] Massachusetts also had a lower motor vehicle fatality rate of 8.2 deaths per 100,000 population as compared to a national rate of 15.4 deaths per 100,000 population.[38]

- This general experience is reflected in low fatal occupational injury rates due to homicide and transportation incidents for Massachusetts. The average annual workplace homicide rate in Massachusetts (0.2 deaths per 100,000 workers) between 2000 and 2007 was half the national rate of 0.4 deaths per 100,000 workers for the same time period. Similarly, the rate of fatal work-related highway transportation incidents in Massachusetts was lower at 0.2 deaths per 100,000 than the national rate of 1.0 death per 100,000 workers.

- The low overall homicide and highway motor vehicle-related fatality rates in Massachusetts, however, provide only a partial explanation for the difference in the fatal occupational injury rates between Massachusetts and the nation. Rates computed excluding homicides and highway motor vehicle-related fatalities reduced, but did not eliminate, the gap between the rate for Massachusetts (1.7 deaths per 100,000 workers) and the national rate (2.7 fatal injuries per 100,000 workers).

- Numerous additional factors likely contribute to the lower fatal occupational injury rates in Massachusetts. These include the following: the comparatively high levels of education and socioeconomic status in Massachusetts, the somewhat higher proportion of unionized workers in the state (14.7% for Massachusetts versus 13.8% for the U.S.),[39] and greater access to emergency medical services.

3.2 *Fatal Event/Exposure*

- As discussed above, the contribution of highway motor vehicle incidents to the occupational fatality burden was low in Massachusetts as compared to the nation (Appendix 2). As a consequence, falls to a lower level accounted for a much higher proportion of the fatal occupational injuries in Massachusetts during the surveillance period (19.1%) than they did in the country as a whole (12%) (Appendix 2). Notably, the rate of fatal falls to a lower level (0.4 deaths per 100,000 workers) was similar to the national rate (0.5 deaths per 100,000 workers).

3.3 *Sex, Age, Race/Hispanic Origin, and Employment Status*

- The distribution of fatal occupational injuries in Massachusetts was similar to national findings with respect to sex, age, and employment status. However, Massachusetts' victims were more likely to be white and less likely to be Hispanic or Black non-Hispanic than victims in the country as a whole, which likely reflects differences in the underlying racial and ethnic compositions of the workforce between Massachusetts and the nation (Appendix 2). As mentioned previously, the high rates of fatal occupational injury for Hispanic workers and older workers observed in Massachusetts have also been reported for Hispanic and older workers nationwide. [4, 17, 40]

[38] Centers for Disease Control and Prevention, National Center for Injury Prevention & Control. Web-based Injury Statistics Query and Reporting System (WISQARS) [online] . 2005 [Accessed 2/6/09] Available from URL: www.cdc.gov/ncipc/WISQARS

[39] The Union Membership and Coverage Database (from the Current Population Survey and Outgoing Rotation Group Earnings, 2004). Covers employed, non-agricultural wage & salary workers 16 years of age and older. Accessed 2/15/09 at http://www.unionstats.com.

[40] Rates calculated from CFOI annual reports indicate the following: 1) the occupational fatality rate for older workers is higher than the rate for younger workers (< 35 years) 2) the occupational fatality rate for Hispanic workers is higher than the rate for White non-Hispanic workers.

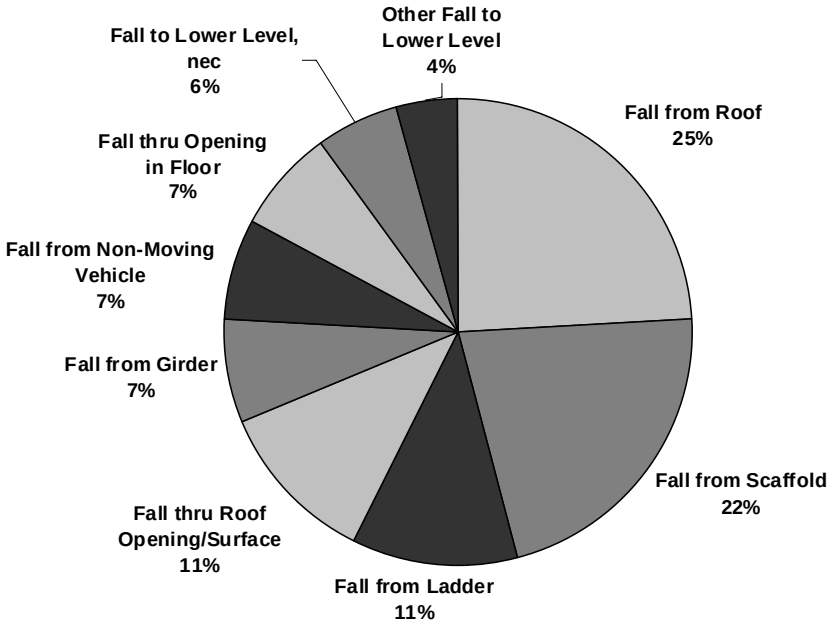
IV. Special Topic – Fatal Falls to a Lower Level in Construction

Workplace falls claimed the lives of 117 Massachusetts workers from 2000 through 2007, accounting for 22% of all fatal occupational injuries during this period. More workers died as a result of falls than any other single event. The eight-year average annual rate of fatal falls for Massachusetts was 0.5 deaths per 100,000 workers, similar to the U.S. rate of 0.6 deaths per 100,000 workers for the same period. The great majority (87.2%, N=102) of the fatal falls in Massachusetts involved workers falling to a lower level. Of these 102 falls, 70 (69%) occurred in the Construction industry. This special topic section focuses on fatal falls to a lower level in construction.

Falls were the leading cause of death among construction workers.

- During 2000-2007, an average of nine construction workers fell to their deaths each year. Falls to a lower level were the leading cause of death among construction workers, accounting for almost half (47.6%) of all construction worker deaths.
- The rate of fatal falls to lower levels among construction workers (4.1 deaths per 100,00 workers) – was close to 10 times higher than the overall rate for all industry sectors (0.4 deaths per 100,000 workers).
- The greatest number of fatal construction falls were from roofs (25%; N=17) and scaffolds (22%, N=15). Falls from ladders and through roof openings each accounted for an additional eight (11%) deaths (Chart 10).

Chart 10. Types of Fatal Falls to a Lower Level in Construction, Massachusetts, 2000-2007 (N=70)



Roofers and carpenters had the highest number of fatal falls to a lower level.

- Roofers (22.9%; n=16) and carpenters (21.4%; n=15) accounted for the greatest number of fatal falls to a lower level among workers in the Construction industry followed by construction laborers (15.7%; n=11), and painters/plasterers (12.9%; n=9). Seven iron/steel workers and four electricians also fell to their deaths (Table 9).

Table 9. Number and Percent of Fatal Falls to a Lower Level in the Construction Industry *by Select Occupations*, Massachusetts, 2000–2007

Occupation	Number of Fatal Falls	Total Fatal Injuries	% of Fatal Injuries Due to Falls
Roofers	16	20	80.0
Carpenters	15	23	65.2
Construction laborers	11	25	44.0
Painters, Plasterers, Construction & Maintenance	9	11	81.8
Structural iron and steel workers	7	10	70.0
Electricians	4	10	40.0
All Construction occupations	70	140	48.6
All Occupations	102	535	19.1

- Whereas falls accounted for 19.1% of all fatal occupational injuries in the state, they accounted for over 80% of deaths among roofers and painters/plasterers carpenters and more than two-thirds (70%) of deaths among structural iron and steel workers (Table 9).

- Concurrent with findings by occupation, the roofing industry accounted for more fatal falls to a lower level (21.4%; n=15) than any other sub-sector within the Construction industry. Residential building construction followed with 13 (18.6%) of the fatal falls in construction (Table 10).

Table 10. Distribution of Fatal Falls to a Lower Level in the Construction Industry *by Selected Industry Sub-sector*, Massachusetts, 2000–2007

Industry Sub-sector	Number of Falls to a Lower Level	% of Total Falls to a Lower Level in Construction
Specialty Trade Contractors	**51**	**72.9**
Foundation, Structure, & Bldg. Exterior Work	28	40.0
- *Roofing, Siding, & Sheet Metal Work*	*15*	*21.4*
- *Structural Steel Erection & Precast Concrete*	*8*	*11.4*
- *Masonry or Framing Work*	*5*	*7.1*
Building Finishing Work (Carpentry, Painting, Wall covering)	11	15.7
Building Equip. Work (Plumbing/HVAC, Electrical)	8	11.4
Other Specialty Trade Work	4	5.7
Other Construction Sub-sectors	**19**	**27.1**
Residential Building Construction	13	18.6
All Construction	70	100

Hispanic workers in the construction industry had high rates of fatal falls to a lower level.

- Eleven of the 70 workers in the construction industry who fell to their deaths were Hispanic. The rate of fatal falls among Hispanic construction workers (8.4 deaths per 100,000 workers) was more than twice the rate among White non-Hispanic construction workers (3.6 deaths per 100,000 workers). Although this difference was of borderline statistical significance, it is consistent with a high rate of fatal falls among Hispanic construction workers reported elsewhere.[41]

Guatemalan Roofer Falls to His Death

A 30-year-old Guatemalan roofer was fatally injured when he fell from the roof of a residential structure. The roofing crew, including the victim, was installing a tarp from a ladder jack scaffold when the victim climbed onto the roof. The victim then fell approximately 30 feet to the ground below, landing on a cobblestone walkway. The victim had been employed with the company for approximately two weeks at the time of the incident, but he had over two years of experience as a roofer. The company owner was the designated person in charge of safety but the company did not have a written safety program and did not provide safety training to employees.

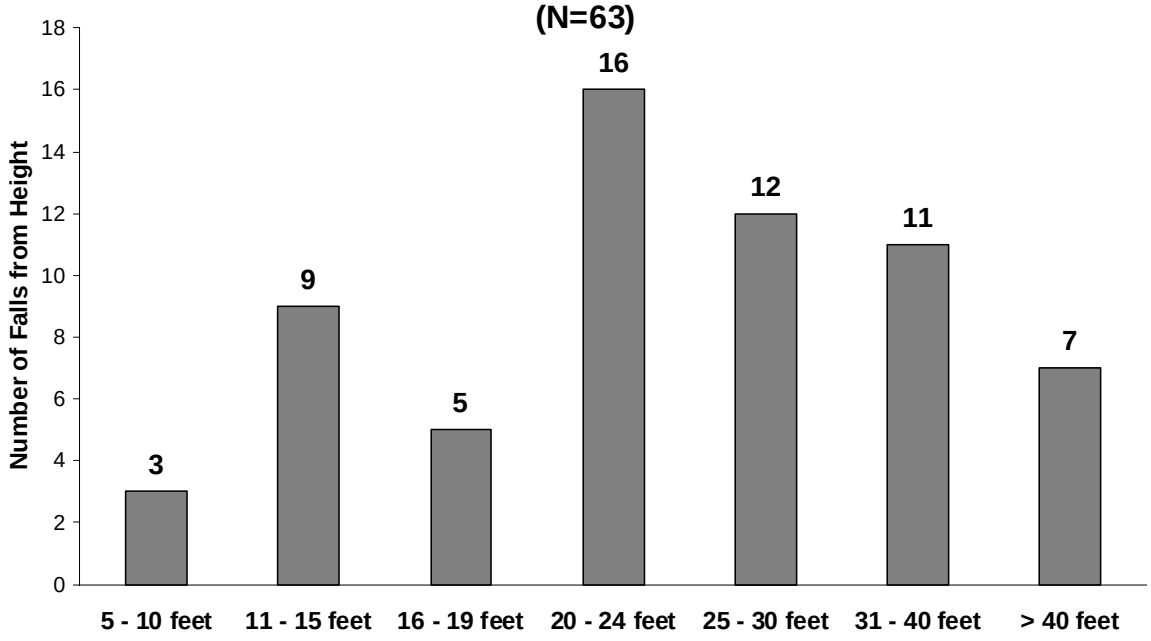
In order to prevent similar incidents, Massachusetts FACE recommended that employers should: 1) develop, implement and enforce a comprehensive safety and health program that includes a fall protection plan that addresses worker protection during scaffold erecting and dismantling; 2) routinely conduct hazard analysis of the work site and revise safety and health procedures and training to address identified hazards ; 3) provide safety training in language(s) and literacy levels of workers; and 4) enforce safety and health regulations and company policies by periodically performing scheduled and unscheduled inspections of employee work practices (Massachusetts FACE report 02MA030).

[41] Personal communication with S. Dong, Center for Construction Research and Training (CPWR).

A majority of fatal falls to lower levels in the construction industry were from heights of less than 25 feet.

- Height information was available for 63 out of 70 fatal falls to lower levels in the Construction industry. The heights ranged from five feet to 200 feet. Of these 63 fatal falls, 52.4% (33 fatalities) were from heights of 24 feet or less (Chart 11), with 12 fatal falls (19.1%) from heights of 15 feet or lower. Seven falls (11.1%) were from heights of 40 feet or higher (Chart 11).

Chart 11. Fatal Falls to a Lower Level in the Construction Industry *by Height of Fall* , Massachusetts, 2000-2007 (N=63)

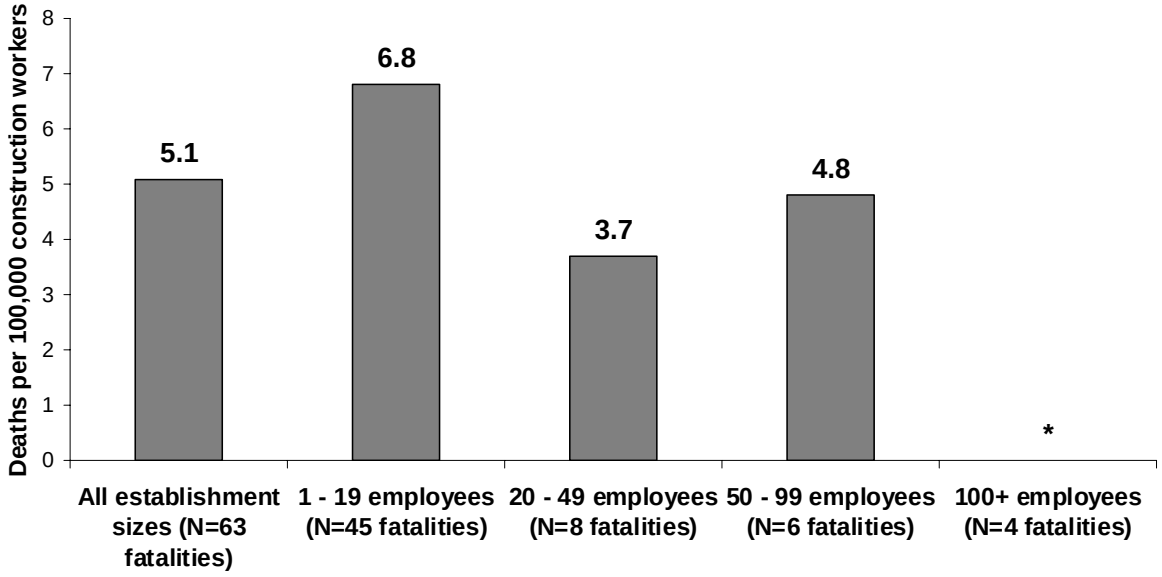


NOTE: Height information was not available for seven fatal falls to lower levels in the Construction industry sector.

Fatal falls in the construction industry were concentrated in small establishments.

- Thirty- six of the 70 fatal falls to lower levels in the Construction sector (51.4%) involved workers employed in establishments with 10 or fewer employees. Another nine fatal falls involved workers in establishments that employed between 11 and 19 workers. The fatal fall rate for construction establishments with 19 or fewer employees was somewhat higher (6.8 deaths per 100,000 workers) than the rate for all construction establishment sizes combined (5.1 deaths per 100,000 workers) but this difference was not statistically significant (Chart 12).
- While 57.1% (40) of the fatal construction falls occurred at road, industrial or commercial construction sites, a substantial number (42.9%; N=30) happened at residential construction sites. Two-thirds (20) of the 30 construction workers who fell to their deaths at residential construction/renovation sites were employed by small contractors with 10 or fewer employees.
- Notably, establishments with fewer than 11 employees are not routinely inspected by OSHA unless a fatality occurs.

Chart 12. Rate of Fatal Falls to a Lower Level in Construction *by Establishment Size* (number of employees), Massachusetts, 2000-2007



NOTE: Rates calculated using 2004 Massachusetts employment estimates for the construction industry from the Quarterly Census of Employment & Wages (QCEW): http://stats.bls.gov/cew/ew04table4.pdf. These data include all establishments and their employees in Massachusetts subject to state and federal unemployment compensation laws. In computing rates, fatalities among self-employed workers were excluded in order to maintain consistency with the denominator (employment) data. Establishment size information was not available for seven fatalities. * Rate not presented due to small number of fatal injuries (< 5).

Preventing Falls to a Lower Level in the Workplace

Surveillance findings underscore falls in construction as a priority for prevention in Massachusetts. Falls in this industry sector should not simply be accepted as part of the job. Comprehensive work-site fall prevention programs, including the use of fall protection systems such as safety harnesses, safety nets, or other fall arrest systems can reduce the risk of fall injuries in construction. The Occupational Safety and Health Administration has established standards for fall protection in construction workplaces (Subpart M, Fall Protection, 29 CFR 126.500-1926.503). Employers should develop and implement comprehensive fall protection programs that, at a minimum, meet these OSHA requirements. The National Institute of Occupational Safety and Health (NIOSH) recommends the following elements as a guide for employers in developing fall-protection programs.[42] Employers should:

- Address all aspects of safety and hazards in the planning phase of projects
- Train employees in the recognition and avoidance of unsafe conditions and the OSHA regulations applicable to their work environment
- Provide appropriate fall protection equipment
- Train workers on the proper use of fall protection equipment, enforce its use, and inspect equipment daily
- Conduct scheduled and unscheduled safety inspections of the work-site
- Address environmental conditions, language differences, alternative methods/equipment to perform assigned tasks, and establish medical and rescue programs

[42] U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Worker Deaths by Falls: A Summary of Surveillance Findings and Investigative Case Reports, November 2000.

- Encourage workers to participate actively in workplace safety

In addition to these general recommendations, NIOSH also recommends specific strategies to prevent falls from ladders, scaffolds, and roofs, common fall hazards both in Massachusetts and across the nation.

To prevent falls from ladders:

- Select and use the proper type of ladder (get the right size and check the duty rating)
- Inspect ladder, prior to using, for structural damage, missing or damaged safety devices, substances that could cause slips or falls, and paint or stickers that could hide defects
- Tag and remove defective ladders from the work-site
- Wear approved fall protection equipment, if applicable
- Use ladders only on solid, stable and level surfaces unless secured to prevent accidental displacement
- Use ladders only as recommended by manufacturer (do not use ladder in a horizontal position as a scaffold, do not have more than one person on the ladder at a time, do not overload, do not work from the top rungs of an extension ladder or the top of a step ladder)
- Maintain ladders regularly (change shoes and lubricate metal bearings, locks and pulleys)
- Train workers on safe use and make sure that they understand and follow safe use of ladders

To prevent falls from scaffolds:

- Select and use the proper type of scaffold for the job
- Provide access ladder to scaffolds
- Use scaffold grade lumber for all platforms
- Install guardrails and toe-boards on all open sides and ends of platforms more than 10 feet above the ground
- Make sure that the footing or anchorage for scaffolds is sound, rigid, and capable of carrying four times the maximum intended load, including its own weight
- Inspect the scaffolding after erection and before first use
- Inspect the scaffolds routinely for consideration of footing (anchorage), parts of the scaffolds, and slippery conditions
- Train workers on the safe way to use scaffoldings

To prevent falls from roofs and buildings:

- Install guarding and/or fall protection on all roof openings
- Put warning signs on all roof openings
- Make cutting the roof openings a last action on the roof
- Provide fall protection measures along unguarded roof perimeters and balconies
- Install a cover (for roof and floor openings) capable of supporting the maximum intended load

Innovative efforts are needed to reach employers and workers in small construction businesses. The Massachusetts Department of Public Health has continued its educational outreach to residential contractors through the dissemination of fall prevention brochures in multiple languages through municipal building permit offices. These materials are available in English, Spanish, Portuguese and Haitian Creole from the Occupational Health Surveillance Program upon request or through the website, www.mass.gov/dph/ohsp. Since 2005, the Massachusetts Department of Public Health has also facilitated discussions among a diverse group of stakeholders representing labor, occupational health surveillance/research, risk management, enforcement, and the community with the purpose of sharing strategies for fall prevention in the construction industry and identifying opportunities for collaboration.

Research and Community Partners: Preventing fall hazards in Massachusetts

Researchers at the Harvard School of Public Health's Department of Environmental Health and the Liberty Mutual Institute for Safety are studying fall-from-ladder hazards with the support of the Center for Construction Research and Training and through partnerships with the Associated General Contractors of Massachusetts and the Consumer Product Safety Commission.

The study aims to identify why people fall from ladders and to estimate the burden of ladder-related fall hazards in the general construction industry of Massachusetts. Researchers will use this information to inform sessions with construction site management on how to make construction sites safer for workers.

The Department of Work Environment at the University of Massachusetts Lowell has received funding from the National Institute for Occupational Safety and Health to conduct community-based participatory research with Laborers Local 175, the City of Lawrence, construction contractors and community based organizations to prevent falls and silica exposure among construction workers, with a special focus on Hispanic construction workers. The project is a partnership of the Lawrence Mayor's Health Task Force, the Laborer's Local 175, and John Snow, Inc. Center for Environmental Health Studies: Casa Leaders.

The project focuses on adapting existing fall prevention programs as well as silica dust prevention technologies for the construction work environment in and around Lawrence. These interventions will be implemented and evaluated for their effectiveness at reducing silica exposure and fall hazards. Effective interventions will be disseminated throughout the Lawrence area. An overall goal of the project will be to institutionalize a community-university-employer-labor partnership that combines the skills and resources of all members to protect the health of vulnerable workers over the long term.

V. Appendices

Appendix 1. Leading Fatal Occupational Events/Exposures and Industries among Racial/Ethnic Groups, Massachusetts, 2000–2007

Hispanic (54)	White non-Hispanic (429)	Black non-Hispanic (22)	Asian non-Hispanic (15)
Top Four Events/Exposures (Number of Fatalities), 2000–2007			
Fall to a lower level (15)	Fall to a lower level (80)	Homicide (8)	Fire or Explosion (3)
Caught/compressed by object, equipment, or collapsing material (7)	Struck by or against object (47)	Caught/compressed by object, equipment, or collapsing material (3)	Homicide (3)
Homicide (7)	Worker Struck by motor vehicle or mobile equip. (40)	Highway motor vehicle-related incident (3)	Struck by or against object (2) *
Highway motor vehicle-related incident (6)	Highway motor vehicle-related incident (39)	Exposure to harmful substance or environment (3)	Suicide/self-inflicted injury (2) *
Top Three Industries (Number of Fatalities), 2000–2007			
Construction (17)	Construction (119)	Services (8)	Construction (6)
Transportation, Warehousing, Communication, & Utilities (incl. sanitation) (8)	Services (93)	Retail Trade (4)	Services (4)
Services (8)	Transportation, Warehousing, Communication, & Utilities (incl. sanitation) (54)	Government (4)	Retail Trade (2)

NOTE: Information about race and Hispanic origin was obtained from death certificates.
SOURCE: Census of Fatal Occupational Injuries (CFOI), Occupational Health Surveillance Program, Massachusetts Department of Public Health, 2000–2007.
* Data provided by the Fatality Assessment and Control Evaluation (FACE) project, Massachusetts Dept. of Public Health, 2000–2007.

Appendix 2. Fatal Occupational Injuries by Select Characteristics, 2000–2007, Massachusetts and United States

Characteristic	MA 2000–2007 Number of fatalities	MA 2000–2007 % of fatalities	U.S. 2000–2007 Number of fatalities *	U.S. 2000–2007 % of fatalities
TOTAL	535	100	45770	100
SEX				
Male	497	92.9	42278	92.4
Female	38	7.1	3492	7.6
RACE/ETHNIC ORIGIN				
White non-Hispanic	429	80.2	32153	70.2
Black non-Hispanic	22	4.1	4460	9.7
Hispanic	54	10.1	7068	15.4
Asian non-Hispanic	15	2.8	1327	2.9
American Indian, Aleut, Alaska Native	- -	- -	315	0.7
Other or not reported	13	2.4	407	0.9
Multiple Races	- -	- -	38	0.1
AGE				
Under 16 years	- -	- -	155	0.3
16 - 19	14	2.6	1067	2.3
20 - 34	37	6.9	3409	7.4
25 - 34	88	16.4	8367	18.3
35 - 44	151	28.2	10688	23.4
45 - 54	129	24.1	10807	23.6
55 - 64	83	15.5	6896	15.1
65 years & over	32	6.0	4340	9.5
EVENT/EXPOSURE				
Transportation Incidents	**166**	**31.0**	**19522**	**42.7**
HWY Motor Vehicle	49	9.2	11002	24.0
Collision b/ vehicles, mobile equip.	31	5.8	5423	11.8
Non-collision incidents	5	0.9	2619	5.7
Non-HWY MV Incident	20	3.7	2710	5.9
Overturned	4	0.8	1417	3.1
Worker Struck by Vehicle, Mobile Equip.	44	8.2	2936	6.4
Water Vehicle Incident	35	6.5		
Aircraft Incident	17	3.2	1696	3.7
Fall	**117**	**21.9**	**6213**	**13.6**
Fall to a lower level	102	19.1	5474	12.0
Fall on same level	14	2.6	- -	- -

Continued on Next Page

Appendix 2. *Continued,* Fatal Occupational Injuries by Select Characteristics, 2000–2007, Massachusetts and United States

Characteristic	MA 2000–2007 Number of fatalities	MA 2000–2007 % of fatalities	U.S. 2000–2007 Number of fatalities	U.S. 2000–2007 % of fatalities
Contact w/ Object or Equip	**91**	**17.0**	**7676**	**16.8**
Struck by object	55	10.3	4462	9.7
Caught/compressed by object, equip., collapsing material	36	6.7	2153	4.7
Caught in running equip or machinery	17	3.2	1083	2.4
Assault or Violent Act	**90**	**16.8**	**6808**	**14.9**
Homicide	49	9.2	4827	10.5
Suicide/self-inflicted injury	39	7.3	1651	3.6
Exposure to Harmful Substance or Environment	**43**	**8.0**	**4005**	**8.8**
Contact with electric current	20	3.7	2043	4.5
Exposure to caustic, noxious, or allergenic substances	14	2.6	990	2.2
Oxygen deficiency (include drowning)	7	1.3	612	1.3
Fire or Explosion	**27**	**5.0**	**1399**	**3.1**
EMPLOYEE STATUS				
Wage & Salary workers	442	82.6	36867	80.5
Self-employed workers **	93	17.4	8903	19.5

***** U.S. fatality counts may be slightly underestimated due to the reporting of additional fatality cases to the Bureau of Labor Statistics after the publication of the data used in this table.
****** Self-employed include paid and unpaid family workers as well as owners of unincorporated businesses. May also include owners of incorporated businesses or members of partnerships.
NOTE: Totals may include data for subcategories not shown separately. Percentages may not sum to totals due to rounding. Dashes indicate data that are not available or do not meet publication criteria.
SOURCES: Census of Fatal Occupational Injuries (CFOI), Occupational Health Surveillance Program, Massachusetts Department of Public Health, 2000–2007.
Census of Fatal Occupational Injuries (CFOI), Bureau of Health Statistics, U.S. Department of Labor, 2000–2007.

Appendix 3. Further Discussion of Statistical Methods

Since the occurrence of a fatal occupational injury in a worker population is considered relatively rare, and the probability of this event happening is small, we used a Poisson regression model to predict a statistical change (i.e. trend) in the occupational fatality rate as a function of time, age, etc.

Ninety-five percent confidence intervals were computed for each rate, defining a range of possible values within which the 'true' value for each rate was likely to lie. The Mid-P test 95% confidence intervals for the rates were calculated using the OpenEpi Software Program version 7.5.11, available at http://www.sph.emory.edu/~cdckms/exact-rate.html. These 95% confidence intervals provided not only a measure of precision for a rate, but they also formed the basis for comparing rates to determine if they were statistically different. If the 95% confidence intervals around two rates being compared did not overlap, then the rates were considered significantly different from one another.